Appendix A
Scoping and Public Outreach

Intrepid Solution Mine Update to the Community

- Dates
    - 8/26/14
    - 8/28/14
- Location
    - Leo Suite Community Center, Carlsbad NM
- Time:
    - Noon to 1
- Invite List
    - Attached
- Attendees
    - Attached
- Comments Heard
    - Overall the comments during the presentations were supportive of the project.
    - There were questions concerning:
        - The performance of the HB Mill
        - Actual Rustler water use vs. modeled
        - Actual cavern performance vs modeled
    - Use of fresh water was a topic as well. It was explained that we are minimizing the use of fresh water as injectate but we learned that a small amount is required in the injectate to keep our injection lines from scaling up. In addition, modifications to the original permits have allowed us to utilize TBR for injectate which recycle process waster previously lost.
    - Can the BLM utilize the information developed in the HB EIS as a basis for the HB Amax EA. BLM representatives responded that they did not see a problem with this approach.

Thursday, August 28, 2014

NAME	Company
Colby Morris	Xcel Energy
Seth Thomason	" "
Joe Hart	attorney
Dick Doss	City Counselor
Sean Dunagan	Sandia National Labs
Jessie Hubbling	BLM
[illegible]	BLM
Roger Nelson	CBFO / U.S. DOE
Don Strickland	Murrell electric
DWAYNE KICKER	Stoller
COURTNEY HERRICK	SANDIA NATL LABS
ROSS KIRKES	SANDIA NATL LABS

Intrepid Update

August 28th Thursday

- 1. Roger Nelson
2. Kyle Marksteiner (Carlsbad focus)
3. Donald (diveplan@aol.com)
4. ~~Wanda Durham~~ (Tues.)
- 5. Don Strickland (muniel)
- 6. Richard Doss City Council
7. Constructors Inc.
8. Constructors Inc.
9. Constructors Inc.
10. Constructors Inc.
11. Constructors Inc.
12. Constructors Inc.
13. Constructors Inc.
- 14. Joe Gant (attorney)
- 15. Colby Morris xcel
- 16. Seth Thomason xcel
17. ~~Ralph Kirkes~~
- 18. Jessie Hubbling BLM
- 19. Craig Cranston BLM
- 20. Sean Dunagan (Sandia)
21. Jeff Campbell - CDOD
22. Ned Elkins
23. Dale Janway (Mayor)
- 24. Courtney Herrick cgherri@sandia.gov
- 25. Dwayne C. Kicker Ph.D. dckicke@sandia.gov
- 26. Ross Kirkes (Sandia)

Tuesday, August 26, 2014

NAME	Company
Jim Rutley	BLM
George MacDonell	BLM
Jimmy Morris	Murrill Electric, LLC
Valerie Murrill	Murrill Electric
Gerald Gould	United Salt
John Vandenkraats	United Salt
E.J. DANZEL	UNITED SALT
Todd S. Hyden	[illegible] Pressure Pumping
Russell Hardy	rhardy@nmsu.edu
ABRAHAM VAN LUIK	DOE
Randy Bailey	[illegible]
Wanda Dunham	Dunham assoc. arch.
Dave Jevich	[illegible] Cleaning
Don Kidd	Western Commerce Bank
Janelle Whitlock	City
Jay Jenkins	CDOD - Carlsbad National Bank
[illegible]	city of Carlsbad

Intrepid Update
August 26th Tuesday

1. Valerie (diveplan@aol.com)
2. Todd Hyden
3. Steve McCutcheon (~~?~~)
4. James Rutley
5. Jeff Campbell (?)
6. David Sepich
7. Gerald Goad
8. John Vandekraats
9. Dan Daniel
10. Jimmy Morris Muriel Electric
11. Ned Elkins (?)
12. Russell Hardy
13. Abraham Van Luik (Vegetarian)
14. Janelle Whitlock
15. Dale Janway (?)
16. Randy Bailey
17. George MacDonell (BLM)
18. Wanda Durham
19. Don Kidd (UCB) former Senator

Cathy 20. Jay Jenkins CDOS/National Bank
Robert
John
Ryan

* lunch for tomorrow Town off (?)
Call ~~Bea~~ Chet & Buy tea

Hanson, Julianne M

From: Hubbling, Jessica <jhubbling@blm.gov>
Sent: Thursday, April 02, 2015 12:02 PM
Subject: Public Notice for proposed Intrepid HB AMAX Extension Solution Mining project

Greetings,

You are receiving this email because you have been identified as an interested party for notification of the proposed solution mining project, the HB AMAX Extension, for Intrepid Potash. The project is currently in a public scoping period that is scheduled to end on April 17th, 2015. Comments will be accepted until close of business on that date. More information can be found on the BLM Carlsbad Field Office webpage at the link below:

http://www.blm.gov/style/medialib/blm/nm/field_offices/carlsbad/docs.Par.50344.File.dat/PUBLIC_NOTICE_Intrepid_HB_AMAX_Extension.pdf

You can also contact me directly with your questions or comments. My contact information is below.
Thank you for your time,

Jessie Hubbling
Geologist
Bureau of Land Management
Carlsbad Field Office
(575) 234-5912

Not
e
: Before including your address, phone number, e-mail address, or other personal identifying information in your comment be advised that your entire comment – including your personal identifying information – may be made publicly available at any time. While we will work to meet any request that personal identifying information be withheld from public review, we cannot guarantee that we will be able to do so.

PUBLIC NOTICE
March 18th, 2015

Intrepid HB AMAX Extension Solution Mining Project

The Bureau of Land Management (BLM) Carlsbad Field Office is initializing public scoping for Intrepid Potash New Mexico for the proposed HB AMAX Extension project to solution mine the abandoned AMAX Potash mine. An Environmental Assessment (EA) is being prepared to assess the potential effects upon environmental resources in the area of the proposed HB AMAX Extension project.

Scoping gives the public a chance to tell the BLM what issues and concerns they think should be addressed in an EA. Public scoping is now underway for the Purpose and Need and Proposed Action sections of the EA (see below). Comments must be received within 30 days from the date of this notice.

This project is a connected action of the existing HB In-Situ Solution Mine Project. The EA for this project will reference the Environment Impact Statement (EIS) completed for the HB in Situ Solution Mining Project (DOI-BLM-NM-P020-2011-498-EIS). The complete EIS with supporting information can be found at the link below.

http://www.nm.blm.gov/cfo/HBIS/finalEIS.html

There will also be a public comment period for this project on the EA in its entirety. The anticipated dates of the EA public comment period are May 4th through June 3rd, 2015. Public comments will be requested via a public notice and all associated documents will be posted in this same location.

Please address any comments to:

BLM Carlsbad Field Office
Attn: Jessie Hubbling
620 East Greene St.
Carlsbad, NM 88220
Phone: 575-234-5912
Fax:575-885-9264
Email: jhubbling@blm.gov

Before including your address, phone number, e-mail address, or other personal identifying information in your comment be advised that your entire comment – including your personal identifying information – may be made publicly available at any time. While we will work to meet any request that personal identifying information be withheld from public review, we cannot guarantee that we will be able to do so.

1. PURPOSE AND NEED FOR ACTION

Background

Intrepid Potash – New Mexico, LLC (Intrepid) is proposing to extract potash, a potassium compound commonly used in fertilizer, which remains in abandoned underground mine workings using solution mining. The proposed HB AMAX Project would be an extension to Intrepid's existing HB Solar Solution Mine located in Eddy County approximately 20 miles east of Carlsbad, New Mexico (see **Map 1 – Project Location and Vicinity Map**) The AMAX Mine is a closed conventional mine that lies to the north of the HB Solar Solution Mine. This project is designed to recover and process potassium chloride (KCl) ore from the abandoned underground mine workings of the AMAX mine.

The HB AMAX Project would tie directly into Intrepid's existing HB Solar Solution Mine and would expand the size and extend the life of the HB solution mine. The Bureau of Land Management (BLM) evaluated the Solar Solution Mine project by preparing an Environmental Impact Statement (EIS), DOI-BLM-NM-P020-2011-498-EIS. A Final EIS (FEIS) was published in January 2012 and a Record of Decision (ROD) followed in March 2012.

The BLM Carlsbad Field Office is evaluating the proposed HB AMAX project with this Environmental Assessment (EA) tiered to the HB Solar Solution Mine EIS. A brief project description follows which details how the proposed HB AMAX project would use existing infrastructure and employ techniques that would minimize impacts. A more detailed description of the project and associated infrastructure can be found in the Proposed Action.

Brief Project Description

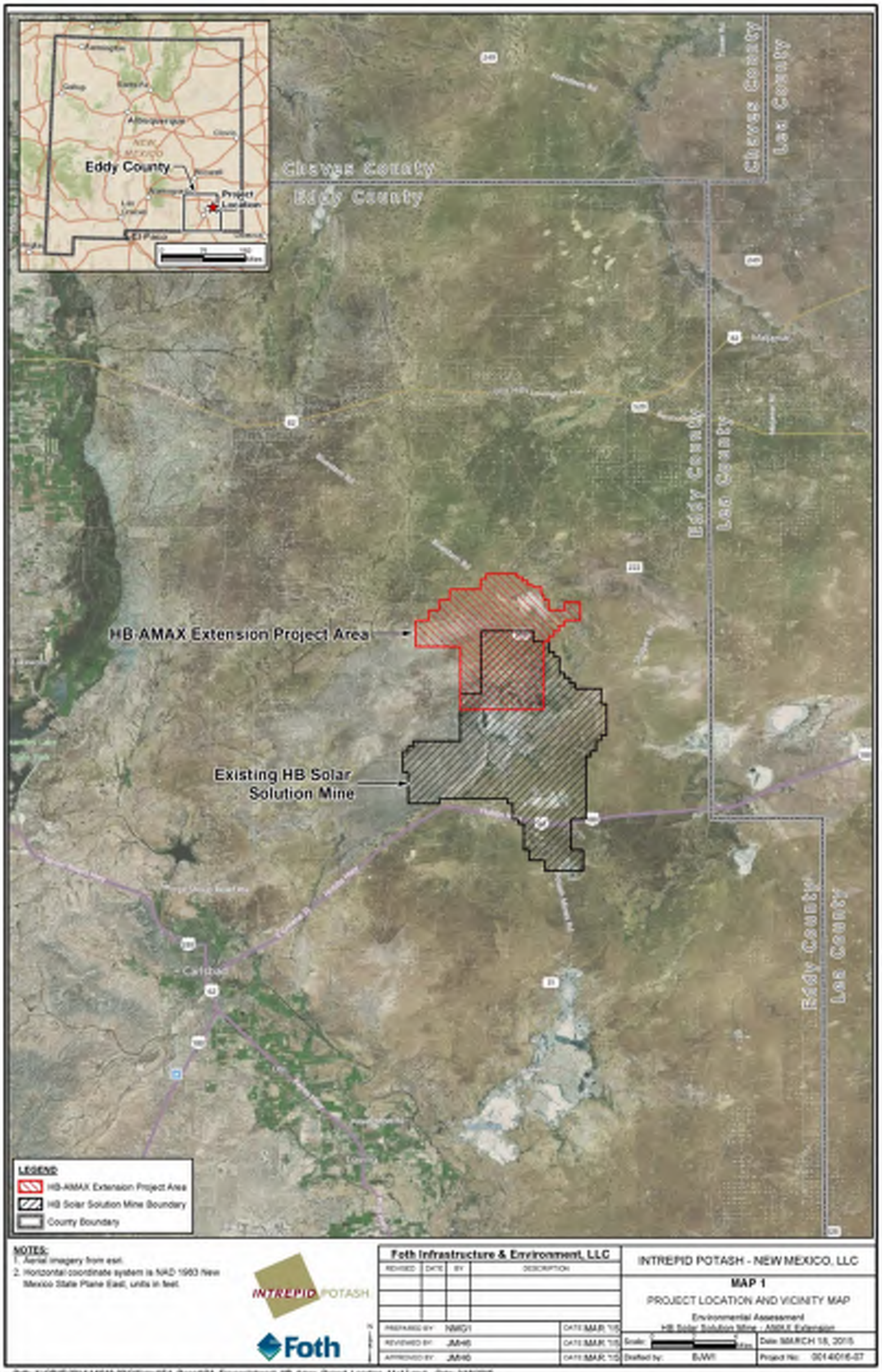
Intrepid holds the federal, state, and private potassium leases for the area of proposed potash extraction. Surface disturbance would occur on BLM, State, and fee lands depending upon the final alignment. The HB AMAX Mine would provide approximately 14 years of solution mine reserves beyond the 28-year HB Solar Solution Mine life.

To the maximum extent practicable, it is proposed that the HB AMAX extension would utilize existing HB Solar Solution Mine facilities and infrastructure to minimize environmental impacts. The solution mining process would be identical to that of the existing HB Solar Solution Mine with injection of salt (NaCl) saturated brine into the workings and extraction of a KCl (potash) enriched (pregnant) brine. Potash recovered from the HB AMAX Mine would be pumped to the existing HB Solar Solution Mine solar evaporation ponds. Once the solution evaporates in the ponds and precipitates out KCL and NaCl solids, the salts would be harvested and transported to the existing HB Mill for ore refinement.

Purpose and Need for Action

The purpose of this action it to modify Intrepid's HB Solar Solution Mine workings to include the AMAX mine in order to recover potash resources.

The BLM is required to evaluate and respond to Intrepid's proposal, described in the Proposed Action, to construct, operate, maintain, and decommission an in-situ solution mining operation. This includes analyzing the impacts of the proposed mine plan modification and the lease conversion from conventional mining to solution mining leases. The need for this project is established by the BLM responsibility to promote the orderly and efficient development and maximum recovery of leasable minerals, including potash, as specified under 30 United States Code (USC) Chapter 2 §21a, the Mineral Leasing Act of 1920 as amended, the Federal Land Policy and Management Act (FLPMA) of 1976 (43 USC 1761), and the Secretary of the Interior's 1986 Potash Order (51 Federal Register 39425, October 28, 1986).



Path: X:\GB\IE\2014\14I016-00\GIS\mxd\EA_Report\PA_Figures\Intrepid_HB_Amax_Project_Location_11x17.mxd Date: 3/18/2015

The BLM is responsible for the balanced management of the public lands and resources and its various values in a fashion that will best serve the needs of the American people. Potash is an important industrial mineral in wide demand in the U.S. The BLM has the duty to allow and encourage a federal leaseholder to develop their leases subject to reasonable restrictions. The proposed project will fulfil the BLM mission and responsibilities by allowing Intrepid to mine potash and associated minerals for which they hold federal leases.

Conformance with Applicable Land Use Plan(s)

The Proposed Action is in conformance with the 1988 Carlsbad Resource Management Plan, as amended by the 1997 Carlsbad Resource Management Plan Amendment for Oil and Gas, and the 2008 Special Status Species Resource Management Plan Amendment.

Relationship to Statutes, Regulations or Other Plans

The BLM authority for land management derives from the Federal Land Policy and Management Act. General BLM regulations are described in 43 CFR, Subtitle B—Regulations Relating to Public Lands, Chapter II—BLM, USDI. BLM regulations for the management of mining on federal potash leases are included in 43 CFR Subpart 3590, Solid Minerals (Other Than Coal) Exploration and Mining Operations—General. Subpart 3592.1, Operating Plans, specifies that before any operations are conducted under any lease, the operator must submit a detailed mine and reclamation plan to the BLM, which the BLM must approve before operations can begin. These regulations contain specific criteria that the mine and reclamation plan must address to assure the protection of non-mineral resources and the reclamation of the lands affected by the operations. It also requires coordination with state agencies.

Potash is a solid leasable mineral that is managed by the BLM under the authority of the Mineral Leasing Act of 1920, as amended, the Potash Leasing Act of 1927, and, in southeastern New Mexico, the 2012 Order. The Mineral Leasing Act establishes qualifications for mineral lessees, defines maximum limits on the total acres of a mineral that can be held by a lessee, and authorizes the BLM to grant these leases. Federal regulations that pertain to leasing these minerals are contained in 43 CFR Part 3500, Leasing of Solid Minerals Other than Coal and Oil Shale.

The State of New Mexico’s Order No. R-111-P applies to state lands and minerals in the area. While the BLM may incorporate elements of R-111-P into its management of the Secretary’s Potash Area, the BLM is not mandated to follow it. In particular, Life of Mine Reserves, as defined in R-111-P, is not used for management of federal lands and minerals.

The Mining and Mineral Policy Act of 1970 (MMPA) mandates that federal agencies ensure that closure and reclamation of mine operations be completed in an environmentally responsible manner. The MMPA states that the federal government should promote the “development of methods for the disposal, control, and reclamation of mineral waste products, and the reclamation of mined lands, so as to lessen any adverse impact of mineral extraction and processing upon the physical environment that may result from mining mineral activities.”

Other major federal and state regulations and permits that are relevant to the proposed project include those listed below:

- NEPA (P.L. 91-190) and CEQ – Regulations for implementing NEPA (40 CFR Parts 1500 – 1508).

- Clean Water Act (CWA) and Federal Water Pollution Control Act Amendments.

- New Mexico Water Quality Act, New Mexico Statutes Annotated (NMSA) 1978, §§74- 6-1 et seq.

- Federal Safe Drinking Water Act, 40 CFR Parts 144 and 147; New Mexico Ground and Surface Water Protection, New Mexico Administrative Code (NMAC) Part 20.6.2, 2005.

- Underground Water, NMSA 1978, §§72-12-1 et seq.

- Endangered Species Act (ESA) of 1973, as amended (P.L. 93- 205).

- Migratory Bird Treaty Act (MBTA) of 1918, as amended; Bald and Golden Eagle Protection Act of 1940.

- Clean Air Act (CAA); delegated to the State of New Mexico under Air Quality Control Act, NMSA 1978, §§74-2-1 through 74-2-17.

- National Historic Preservation Act (NHPA) (36 CFR Part 800); New Mexico Cultural Properties Act, NMSA 1978, §§18-6-1 through 18-6-17.

- Federal Cave Resources Protection Act of 1988, 16 USC 4301 – 4309.

- P. L. 111-011 Omnibus Public Land Management Act, Subtitle D – Paleontological Resources Preservation.

- NMSA 1978 Sections 19-1-1 and 19-7-57.

- NMAC Part 14.5.2.

This EA is tiered to the HB In-Situ Project (now referred to as the HB Solar Solution Mine EIS, DOI-BLM-NM-P020-2011-498-EIS. The FEIS was published in January 2012 and the ROD followed in March 2012. The analyses contained in this EIS are incorporated into this EA by reference. The analyses can be found on pages 3-1 through 3-129 and 4-1 through 4-125 in the EIS.

Decision to be Made

The decision to be made is whether or not to approve Intrepid's application to extend the existing HB Solar Solution Mine workings to include the AMAX mine, and, if to approve, under what terms and conditions.

2. PROPOSED ACTION

Introduction

Intrepid is proposing to expand solution mining activities permitted for the HB Solar Solution Mine to include portions of the abandoned AMAX Horizon Mine. The HB Solar Solution Mine and the proposed HB AMAX Extension are located in Eddy County approximately 20 miles east of Carlsbad, New Mexico.

The HB AMAX Extension Project would expand Intrepid's existing HB Solar Solution Mine and is proposed as a Mine Plan Modification of Intrepid's existing HB Solar Solution Mine Operations and Closure Plan, dated March 9, 2012. The proposed extension project lies completely on potassium leases held by Intrepid and thus can be permitted as a mine plan modification. No separate Rights-of-Way (ROW) in addition to the mine modification are proposed for in this project.

The proposed HB AMAX Extension is located within state, federal, and private leases that Intrepid currently holds. As part of this Proposed Action all federal potassium leases associated with the proposed HB AMAX Extension would be converted from conventional mining leases to solution mining leases. The same conversion of lease type was analyzed for the existing HB Solar Solution Mine EIS (see Record of Decision). Four federal potash leases are to be converted from conventional mining leases to solution mining leases. These leases are listed in **Table 1 – Existing and Proposed HB Solar Solution Mine Facilities** below and shown on **Map 2 – Mineral Lease.**

Table 1 – Existing and Proposed HB Solar Solution Mine Facilities

Lease Number	Total Lease Acreage
NMLC-046729-D	2,560.0
NMNM-113455	2,400.8
NMNM-113456	2,480.0
NMNM-113457	560.6

The AMAX Mine ceased production in 1993 and has been closed as per applicable regulatory requirements. The shafts have been sealed and the surface restoration and reclamation activities have been completed by the former owner. The remaining ore is located in the pillars and fringe areas of the underground mine workings.

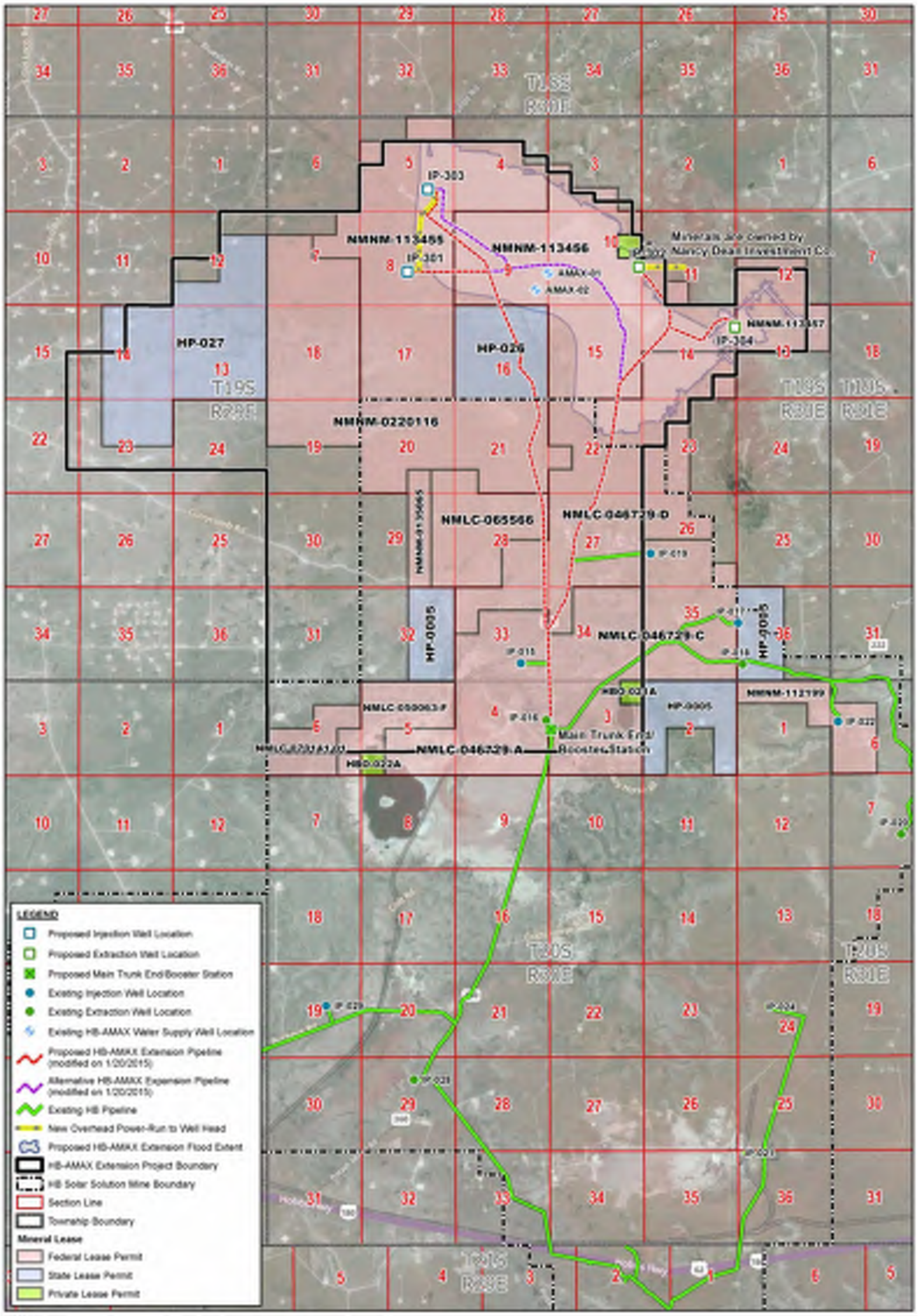
Conventional mining at the AMAX property occurred on the First and Third Ore Zones. The Third Ore Zone lies stratigraphically above the First Ore Zone with roughly 30 feet of separation between them. The two Ore Zones are connected by several slopes and stopes that would allow injected brine to move vertically providing contact to ore in pillars and fringe areas from both ore zones.

The HB AMAX Extension would utilize existing facilities wherever possible. The infrastructure associated with the HB Solar Solution Mine and the proposed HB AMAX Extension is shown on **Map 3 – *Existing and Proposed HB Solar Solution Mine Facilities***. All existing infrastructure for the HB Solar Solution Mine that would be also used by the HB AMAX Extension was previously analyzed in the HB In-Situ Solution Mine EIS.

As shown on Map 3, new construction for the HB AMAX Extension would include:

- Two injection wells with 80 feet by 80 feet operational areas.
- Two extraction wells with 80 feet by 80 feet operational areas.
- Two Pilot/Testing/Instrumentation (PTI) wells (one PTI well immediately adjacent to each extraction well and contained within each 80 feet by 80 feet operational area).
- 12.4 miles of 50-foot wide utility corridor that will include buried pipelines of various diameters (4 to 18 inches) and 12-foot wide access roads.
- One booster pump station.
- 1.6 miles of overhead electric lines.
- One additional source of injectate brine make-up water from the Intrepid North plant scrubber recycle system.

The HB Solar Solution Mine currently employs several monitoring systems and networks to verify and document operational conditions as required by the New Mexico Environment Department and the BLM. All existing monitoring systems would be utilized for the proposed HB AMAX Extension and are summarized as follows:



NOTES:

1. Aerial imagery from esri.
2. Locations of existing pipelines, existing wells, proposed HB-AMAX pipelines, and proposed HB-AMAX wells provided by Intrepid Potash, LLC and further defined through field surveys.
3. Final pipeline route to be surveyed upon regulatory approval.
4. Horizontal coordinate system is NAD 1983 New Mexico State Plane East, units in feet.

INTREPID POTASH

Foth

Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	NMG1	DATE MAR.'15
REVIEWED BY:	JMHB	DATE MAR.'15
APPROVED BY:	JMHB	DATE MAR.'15

INTREPID POTASH - NEW MEXICO, LLC

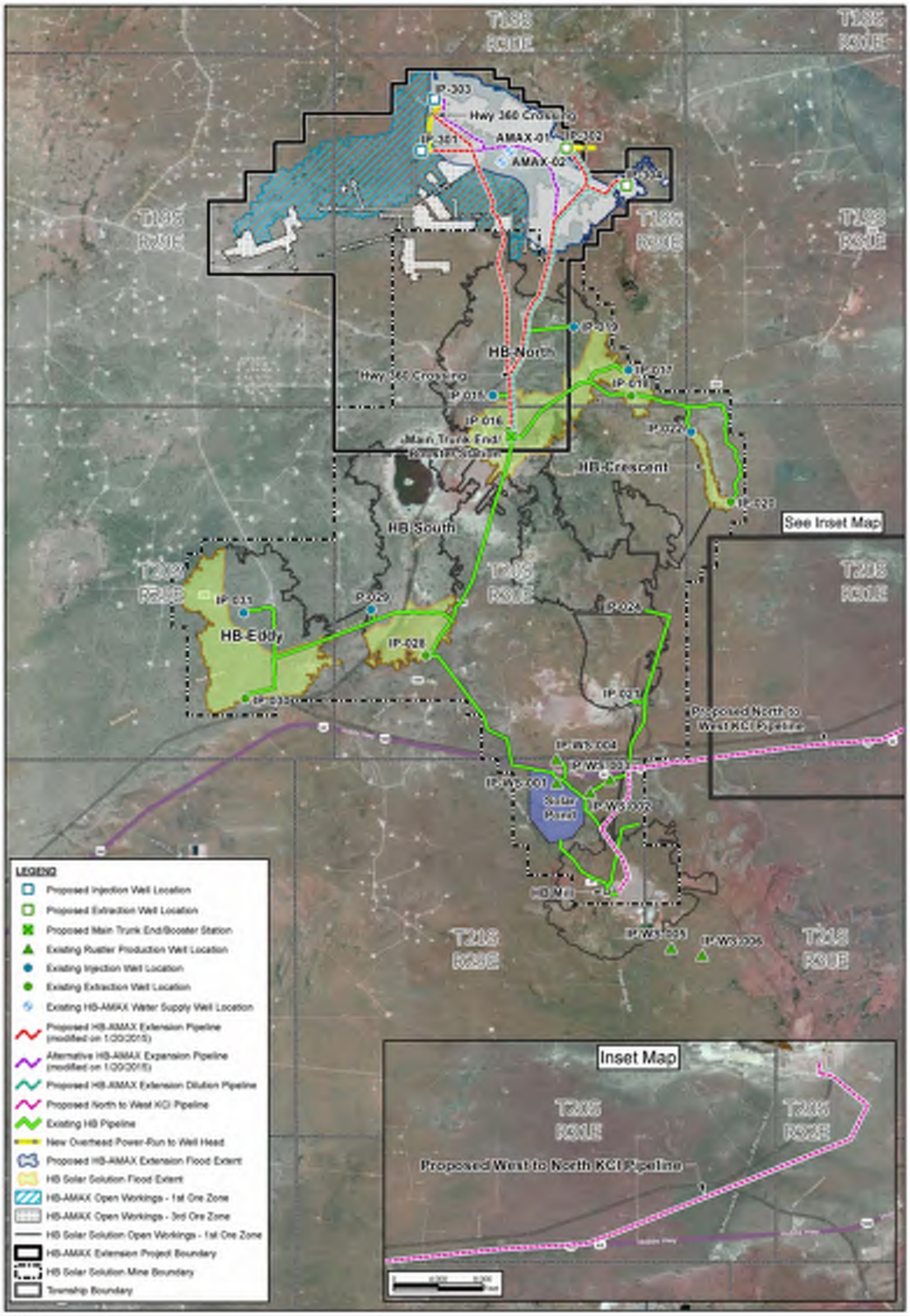
MAP 2

MINERAL LEASE

Environmental Assessment
HB Solar Solution Mine - AMAX Extension

Scale: 0 2,500 5,000 Feet	Date: MARCH 18, 2015
Drafted by: BJW1	Project No: 0014I016-07

Path: X:\GB\IE\2014\14I016-00\GIS\mxd\EA_Report\PA_Figures\Intrepid_HB_Amax_Project_MineralLease_11x17.mxd Date: 3/18/2015



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3. Final pipeline route to be surveyed upon regulatory approval.
4. Horizontal coordinate system is NAD 1983 New Mexico State Plane East, units in feet.

INTREPID POTASH

Foth

Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION
PREPARED BY	NMG1	DATE	MAR '15
REVIEWED BY	JWH6	DATE	MAR '15
APPROVED BY	JWH6	DATE	MAR '15

INTREPID POTASH - NEW MEXICO, LLC

MAP 3
EXISTING AND PROPOSED HB SOLAR SOLUTION MINE FACILITIES
Environmental Assessment
HB Solar Solution Mine - AMAX Extension

Scale:	Date: MARCH 18, 2015
Drafted by: BJW1	Project No: 0014I015-07

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- A groundwater monitoring well network used to collect regular water level and water quality data throughout the area influenced by Rustler groundwater withdrawal.

- A groundwater monitoring well network used to collect regular water level, water quality, and electrical conductivity data to define baseline characteristics of the groundwater beneath the solar evaporation ponds and monitor for potential releases of solar pond brine.

- Regular water level measurements collected continuously or monthly to monitor water levels specified karst and cave resources.

- Regular pipeline inspections by mine personnel and pipeline instrumentation that monitors pressure and flow rate to monitor for potential pipeline leaks.

- Down-hole instrumentation to guide extraction well and injection well operation and control flood elevations.

- Monitoring wells to detect potential brine excursions to down-gradient portions of the mine workings outside of flood zones.

Map 3 shows the existing infrastructure associated with the HB Solar Solution Mine and the proposed HB AMAX Extension.

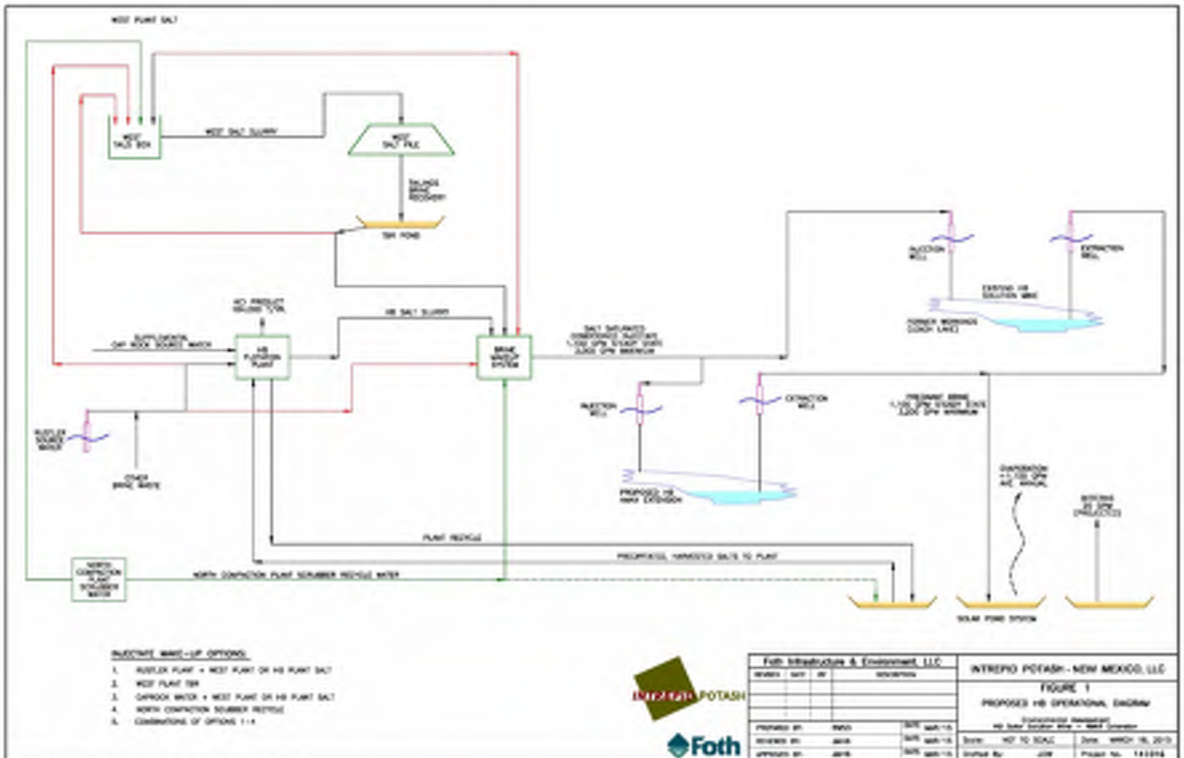
HB AMAX Extension Mine Operation

The solution mining process at the proposed HB AMAX extension would be identical to that employed at the existing HB Solar Solution Mine. The proposed HB AMAX solution mining process is to inject a salt (NaCl) saturated brine into the AMAX workings. The brine would remain in place to allow an ion exchange to occur between KCl in the mine ore body and sodium in the brine (KCl in the ore body is dissolved and an equivalent amount of NaCl precipitates out from the brine). The result would be a potassium-rich (pregnant) brine to be extracted from the mine after a desired concentration of potassium is reached. Pregnant brine would be pumped to the existing HB solar evaporation ponds. Water in the pregnant brine would evaporate in the ponds and KCl and NaCl would precipitate out as solids. The precipitated salts would be harvested from the ponds and transported to the existing HB Mill for ore refinement. This process is described in detail in the HB EIS (Section 2.4.2.2).

Salt conditioned injectate brine would be pumped to injection wells located in upper elevations of the HB AMAX Mine and would flow to the lower areas of the flood zone. As injectate brine is added, a leach lake would form and rise to the maximum control elevation. After the brine is injected it would flow via advection (gravity induced, downhill flow) and dispersion (driven by density gradients developed as the brine becomes increasingly saturated with KCl). Although it would take time to fill the HB AMAX Mine (over two years at the maximum injection rate of 3,000 gpm), KCl dissolution is expected to occur quickly but may take several month to concentrate to the desired pregnant brine KCl grade. The in-situ process would leave behind insolubles (clay slimes) in the former workings eliminating the need for separation and disposal on the surface. Once the cavern is filled to the control level, long term production would become a relatively steady-state operation where injection roughly equals extraction. **Figure 1 - Proposed HB Operational Diagram** summarizes the cumulative HB solar solution mine processes including the proposed HB AMAX Extension.

Proposed Construction

The proposed new construction required for the HB AMAX Extension includes new injection wells, extraction wells (with associated PTI wells), well head components, conveyance pipelines, booster station, power distribution facilities, and access roads. The following subsections present details of the proposed infrastructure and the design features related to environmental protection.



WEST PLANT SALT
WEST SALT SLURRY
WEST SALT PILE
TBR POND
HB SALT SLURRY
BRINE MAKEUP SYSTEM
PLANT RECYCLE
PROPOSED HARVESTED SALTS TO PLANT
NORTH COMPACTION PLANT SCRUBBER RECYCLE WATER
INJECTION WELL
EXTRACTION WELL
SOLAR POND SYSTEM
INJECTATE MAKE-UP OPTIONS:
1. RUSTLER PLANT + WEST PLANT OR HB PLANT SALT
2. WEST PLANT TBR
3. CAPROCK WATER + WEST PLANT OR HB PLANT SALT
4. NORTH COMPACTION SCUBBER RECYCLE
5. COMBINATIONS OF OPTIONS 1-4
Foth Infrastructure & Environment, LLC
INTREPID POTASH - NEW MEXICO, LLC
FIGURE 1
PROPOSED HB OPERATIONAL DIAGRAM
NOT TO SCALE
MARCH 18, 2013

Injection/Extraction Well Locations
Two injection and two extraction wells are proposed to provide conduits to flood the target ore zones as follows:

- **<u>IP-301</u>** 1^{st} Ore Zone Injection Well
  NW ¼, SE ¼, Section 8, T19S, R30E

- **<u>IP-302</u>** 1^{st} Ore Zone Extraction Well
  NE ¼, SE ¼, Section 10, T19S, R30E

- **<u>IP-303</u>** 3^{rd} Ore Zone Injection Well
  SE ¼, SE ¼, Section 5, T19S, R30E

- **<u>IP-304</u>** 3^{rd} Ore Zone Extraction Well
  NE ¼, NE ¼, Section 14, T19S, R30E

The injection and extraction wells are classified as Class V injection wells for in-situ mineral processing and would be constructed using a similar design as the injection and extraction wells approved and installed for the HB Solar Solution Mine (See Section 2.4.2.1 of the HB EIS). The following figures illustrate the injection and extraction well design:

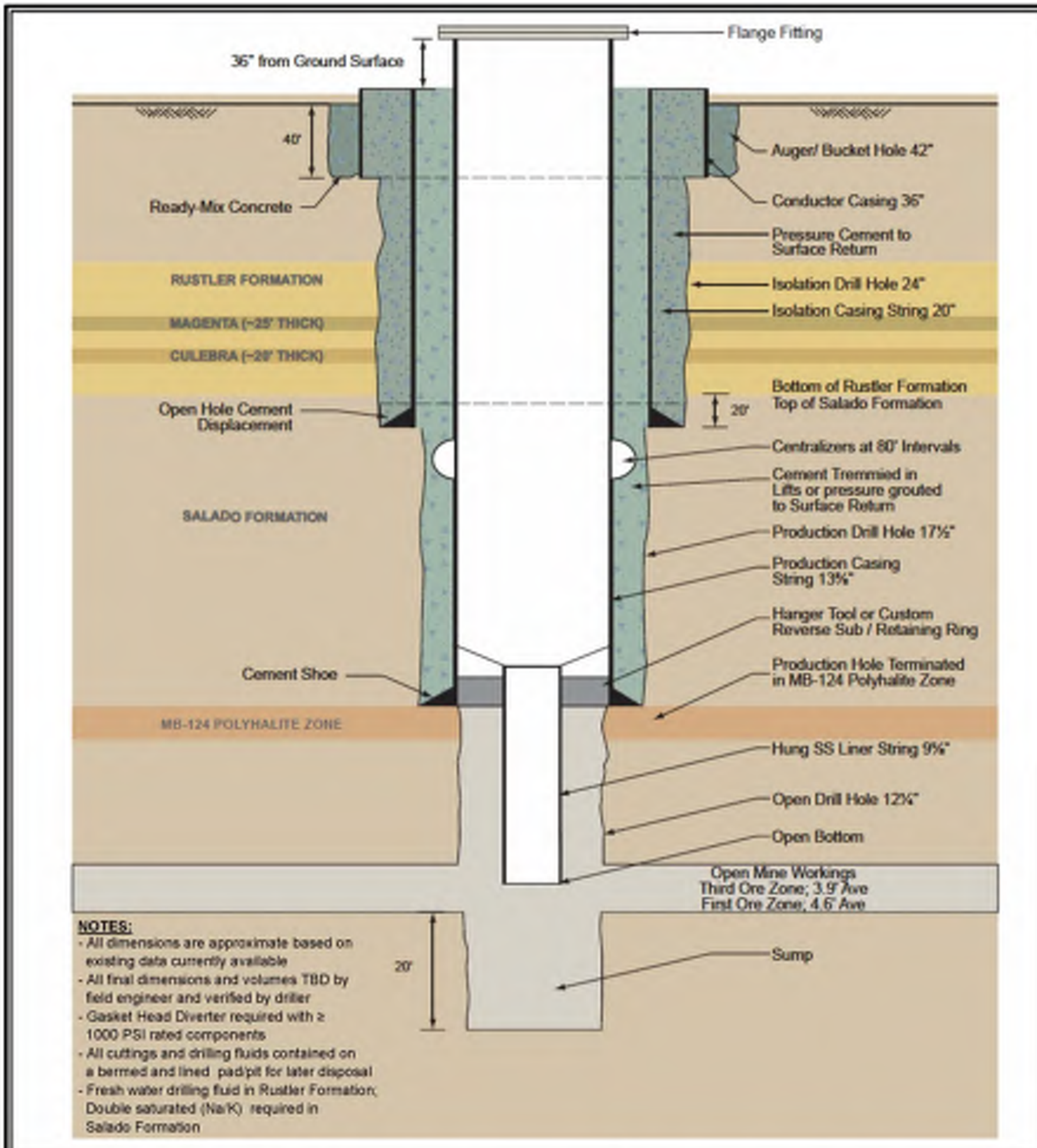
- **Figure 2 – Injection Well General Design**
- **Figure 3 – Extraction Well General Design**

Proposed wells IP-301 and IP-302 may require modifications to the drilling and well completion design based on the occurrence and condition of the Third Ore Zone as drilling passes through it. Any modification to an approved plan would be notified to the BLM prior to construction.

Injection and Extraction Well Access and Drill Pads
Access routes to the injection and extraction well locations shall be via the pipeline routes which include an inspection/maintenance road within the utility corridor. The drill pad would be cleared and grubbed of vegetation and graded to facilitate well installation. Cleared vegetation would be randomly scattered outside the drill pad and not left in piles or rows. The disturbance area would be graded to the degree necessary to allow drilling and well construction activities. In the event that graded surface materials cannot support drilling and support equipment, a lift of caliche may be applied. The caliche would be supplied by an area contractor/supplier from sources controlled by that contractor. The drill pad and associated disturbance area would be 150 feet by 250 feet and would contain all drilling equipment, drilling material storage, subcontracted services such as drilling fluid supply and delivery, cementing, casing installation, geophysical logging, fueling, etc. The site would contain bermed and lined pits, tanks, and other components to manage drill cuttings and drilling fluids. The sites would also be bermed and equipped with straw booms on the down-slope edges to serve as secondary containment.

All fuels and lubricants would be contained in secondary containment facilities. Drilling and well construction would be performed on a 24/7 shift rotation and the location would contain portable sanitary facilities, office/maintenance trailers, and light plants. Once drilling activities are complete, all well construction equipment, left over materials, and waste would be removed from the site. Following well head construction associated with the surface control facilities, which would be contained within an 80-foot by 80-foot fenced area within the drill pad, the well pad would be graded and seeded with a seed/fertilizer mix as specified by the BLM. If caliche was used to stabilize the pad, all caliche would be removed from the site prior to reclamation

Figure 4 – General Drill Pad Layout illustrates the drill pad configuration for the injection and extraction wells. All pad, drilling and well construction activities would be overseen and directed by qualified personnel. The technical site representative would be responsible for all decisions regarding drill depths and well completion details.



INTREPID POTASH.

Foth

Foth Infrastructure & Environment, LLC					INTREPID POTASH - NEW MEXICO, LLC	
REVISED	DATE	BY	DESCRIPTION		FIGURE 2	
					INJECTION WELL GENERAL DESIGN	
					Environmental Assessment HB Solar Solution Mine - AMAX Extension	
PREPARED BY:	NMG1			DATE MAR.'15		
REVIEWED BY:	JMH6			DATE MAR.'15	Scale: NOT TO SCALE	Date: MARCH 18, 2015
APPROVED BY:	JMH6			DATE MAR.'15	Drafted by: DAT	Project No: 0014I016-05

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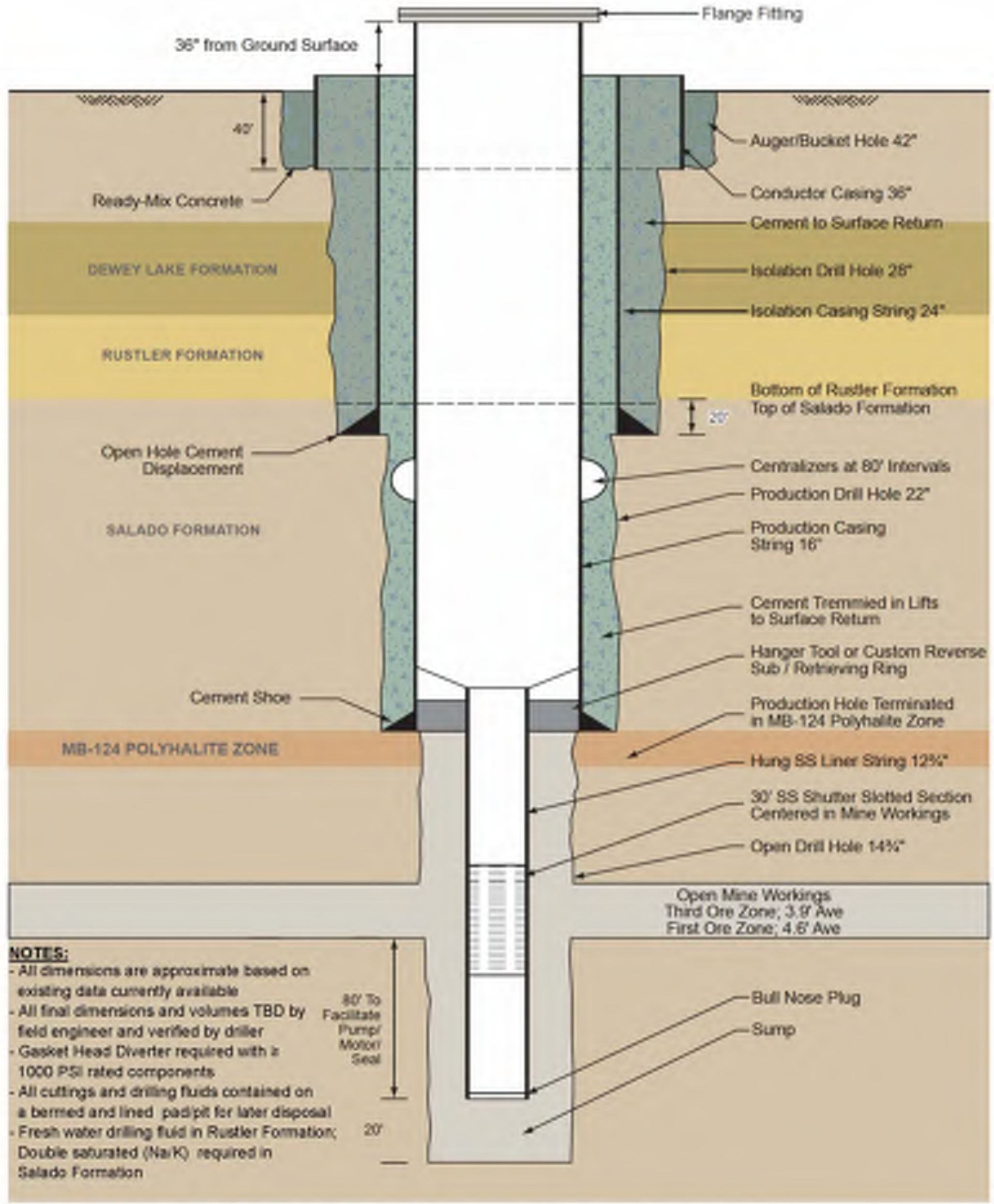

INTREPID POTASH.

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Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	NMG1	DATE MAR.'15
REVIEWED BY:	JMH6	DATE MAR.'15
APPROVED BY:	JMH6	DATE MAR.'15

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FIGURE 3

EXTRACTION WELL GENERAL DESIGN

Environmental Assessment
HB Solar Solution Mine - AMAX Extension

Scale:	NOT TO SCALE	Date:	MARCH 18, 2015
Drafted by:	DAT	Project No:	0014I016-05

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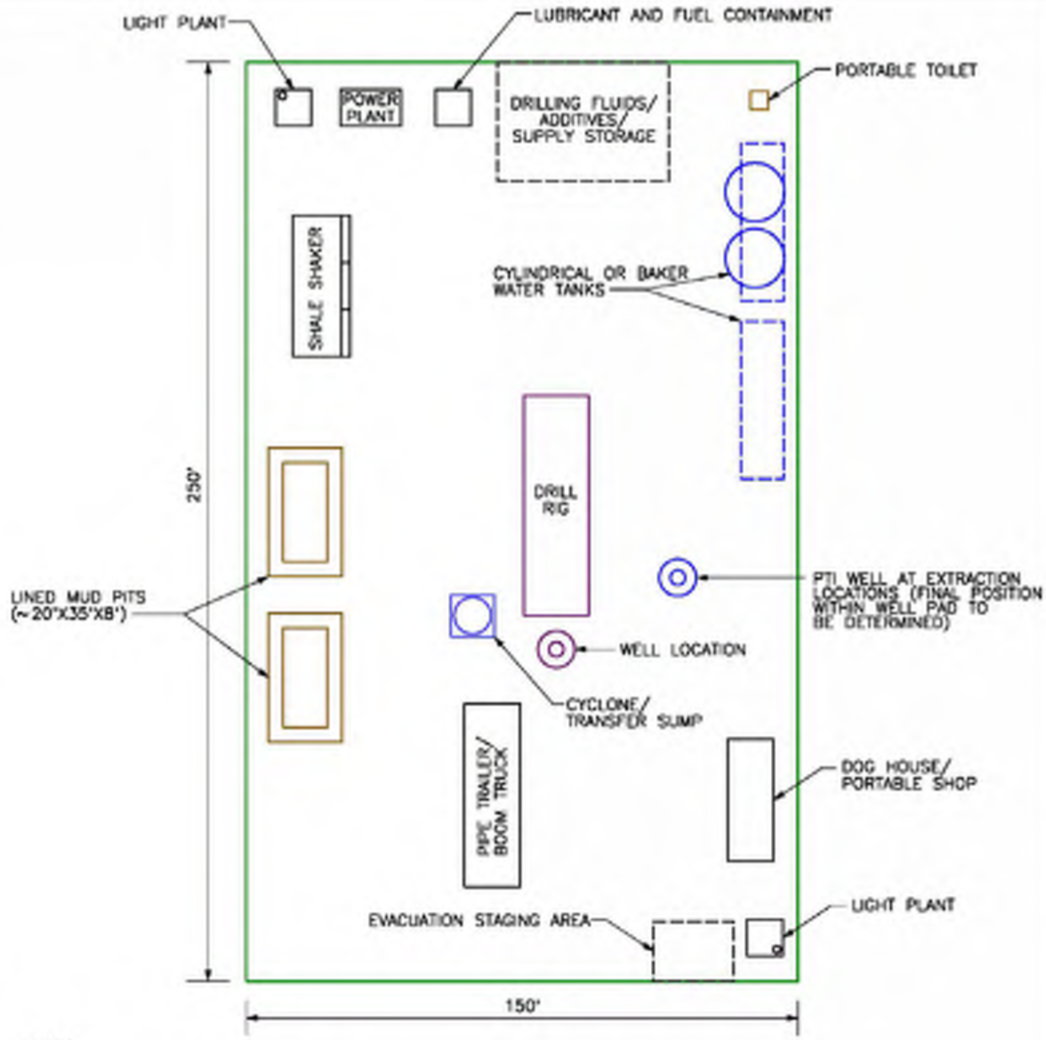

NOTES:

1. 150' X 250' WORKING SURFACE.
2. TO BE RECLAIMED BACK TO A 80'X80' OPERATING SURFACE.
3. PADS TO BE GRUBBED AND GRADED LEVEL.
4. SMALL BERM AND STRAW WATTLES PLACED ALONG EXTERIOR BOUNDARY.
5. DRILLING FLUIDS, DRILLING MUDS, AND CUTTINGS TO BE DISPOSED OF WITHIN THE TAILINGS AREA OF THE FORMER PCA FACILITY.
6. PAD CORNERS STAKED WITH STEEL POSTS.
7. THE PAD MAY BE SURFACED WITH A CALICHE BASE AS SITE CONDITIONS DICTATE.

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REVISED	DATE	BY	DESCRIPTION
PREPARED BY:	RWS3	DATE:	MAR.'15
REVIEWED BY:	JMH6	DATE:	MAR.'15
APPROVED BY:	JMH6	DATE:	MAR.'15

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FIGURE 4

GENERAL WELL PAD LAYOUT

Environmental Assessment
HB Solar Solution Mine – AMAX Extension

Scale:	NOT TO SCALE	Date:	MARCH 18, 2015
Drafted By:	JOW	Project No.	141016

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Well Head Infrastructure

Each of the four well locations would be equipped with operating infrastructure to facilitate brine injection and extraction as follows:

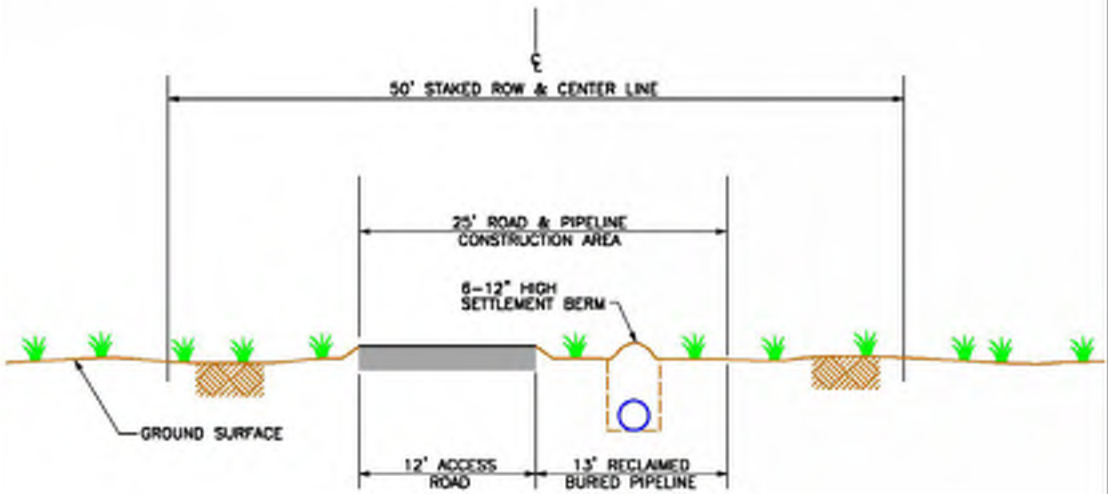
- Well head manifold and valving.
- Power transformation and motor control components.
- Well head security and fencing.
- Down-hole equipment.

All four well head areas would utilize an 80 feet by 80 feet operational area for the life of the operation. All equipment would be contained within the 80 foot by 80 foot area. The working area would contain various electrical cabinets for instrumentation, motor control/variable frequency drive, and power transformation/distribution mounted on concrete pads. Manifold piping inclusive of various vents, valves, sample ports, and instrumentation would be connected from the well to the distribution piping via flanged fittings to facilitate future maintenance. The operational area would also include telemetry and distributed control system equipment to transfer data and allow remote operation of the well site. The telemetry system is anticipated to consist of a radio-based network that would tie into the existing HB Solar Solution Mine telemetry system and would require small antennas at each of the well heads. Key control and instrumentation would include manifold and pipeline pressure monitoring, injection and extraction flow rates, mine flood level elevations, site security features, and various power parameters such as voltage, amperage, pump speed, etc. Any area within the 80 foot by 80 foot operating area that falls outside of concrete pad footprints would feature a gravel base and be fenced with a 4 strand wire fence with access gates as per BLM stipulations. The immediate area containing the extraction or injection well, the wellhead piping manifold, and the electrical cabinetry would be surrounded by a shaded, chain link fence with locking gates. Power would be brought to the site via overhead service terminating adjacent to the operating area. Power would be transformed to three phase 480 volt and then run underground to electrical transforming cabinetry within the operating area and distributed to various components within the operating area.

Access Piping and Roads

Injection brine would be transported from the northern extent of the existing HB Solar Solution Mine main trunk injection line to injection wells IP-301 and IP-303 (see Map 3). The new high density polyethylene (HDPE) injection pipelines would be designed to provide sufficient diameter and strength to convey up to 3,000 gpm at 228 PSI. The injection pipelines would be constructed with extrusion welded and/or flanged 18-inch diameter, SDR-9 HDPE pipe. The pipeline would be equipped with manual isolation valving, vent and vacuum relief valves, and pressure monitoring points as needed to monitor brine flow, as part of the leak detection system. All injection lines would be buried with a minimum of 2 feet of fill over the pipe. During construction open trenches would be limited to ½ mile in length or escape ramps would be installed every ¼ mile. Once backfilled, a 6 to 12-inch mound would be left over the pipeline to allow for settlement. Blinded wyes would be installed approximately every 1,500 feet to provide access for maintenance. All pipeline access points for instrumentation, monitoring or control would be within vaults or small areas of pipeline surface exposure.

The injection line would cross State Highway (STH) 360 at one new location as shown in Map 3. The STH 360 crossings would be facilitated by boring and jacking beneath the highway as described in Section 2.4.2.1 of the HB EIS. A New Mexico Department of Transportation (NMDOT) permit would be obtained for these crossings. The ROW area of construction disturbance would be 50-foot wide. Within the 50-foot ROW containing the buried pipeline, a 12-foot wide access road would be established to allow the pipeline to be inspected on a regular basis. The access road would also provide access for maintenance and routine monitoring of the instrumentation. **Figure 5 – Typical Pipeline ROW Section** illustrates the pipeline footprint. Upon completion of pipeline and access road construction all disturbance within the 50-foot ROW would be seeded, fertilized, and mulched as per BLM requirements and Conditions of Approval.



NOTES:

1. ALL ACCESS & DISTURBANCE CONFINED TO 50' ROW.
2. 12' ACCESS ROAD FOR PIPELINE INSPECTION TO BE OPERATIONAL FOR THE LIFE OF THE PROJECT.
3. ALL PIPELINES BURIED & BEDDED AS PER SPECIFICATIONS.
4. CERTAIN SECTIONS OF ACCESS ROAD MAY REQUIRE CALICHE SURFACE AS OPERATIONAL CONDITIONS DICTATES.
5. ALL DISTURBED SURFACES SHALL BE GRADED, FERTILIZED, SEEDED & MULCHED AS PER SPCIFICATIONS.

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REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	RWS3	DATE:	MAR.'15
REVIEWED BY:	JMH6	DATE:	MAR.'15
APPROVED BY:	JMH6	DATE:	MAR.'15

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FIGURE 5

TYPICAL PIPELINE ROW SECTION

Environmental Assessment
HB Solar Solution Mine – AMAX Extension

Scale: NOT TO SCALE	Date: MARCH 18, 2015
Drafted By: JOW	Project No. 141016

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The brine extraction pipeline and associated dilution water line would be extended from the existing HB Solar Solution Mine pipeline network to each HB AMAX extraction well as detailed in Section 2.4.2.1 of the HB EIS. The extraction and dilution lines would be buried together for their entire length. The pipeline bundle would cross STH 360 at the location (see Map 3) of the existing HB Solar Solution Mine injection line crossing in Section 33 to minimize disturbance areas. The extraction pipeline has been designed to convey up to 2,000 gpm at 160 PSI. The extraction line would consist of 12-inch and 16-inch diameter, SDR-11 HDPE pipe and the dilution line would be composed of 4-inch and 6-inch diameter, SDR-9 HDPE pipe. The new pipelines installed as part of the proposed HB AMAX extension would be buried with a minimum 2 feet of cover.

The pipeline leak detection system consists of routine inspections by Intrepid personnel to observe for potential pipeline leaks and monitoring with automated instrumentation to minimize the potential for unauthorized discharges of the transport brine.

Booster Pump Station

Hydraulic analysis of the proposed HB AMAX injection pipelines indicates that a pump station would be required to achieve maximum desired flow rates within prescribed operating of the pipeline. Accordingly, a booster pump station is proposed to be installed where the new HB AMAX injection line connects to the existing HB Solar Solution Mine injection line main trunk. **Figure 6 – Booster Pump Station Plan** illustrates the booster pump station location. The pump station would require a graded footprint of 130 feet by 100 feet and would contain a primary pump, standby/back-up pump, a building to house the pumps, power transformation, and motor controls. The site would also include instrumentation, data acquisition, and automated controls connected by radio repeater to the adjacent HB Solar Solution Mine well facilities which would be routed to the HB control center. The booster pump station is estimated to require 350 HP driven operations. Power would be supplied by the existing overhead power line to well IP-016. The booster station would be fenced with a 4 strand wire fence and access gates would be installed along the access pipeline roadway per BLM requirements. Figure 6 shows the booster station location, configuration, and how the maintenance access road would be constructed and maintained.

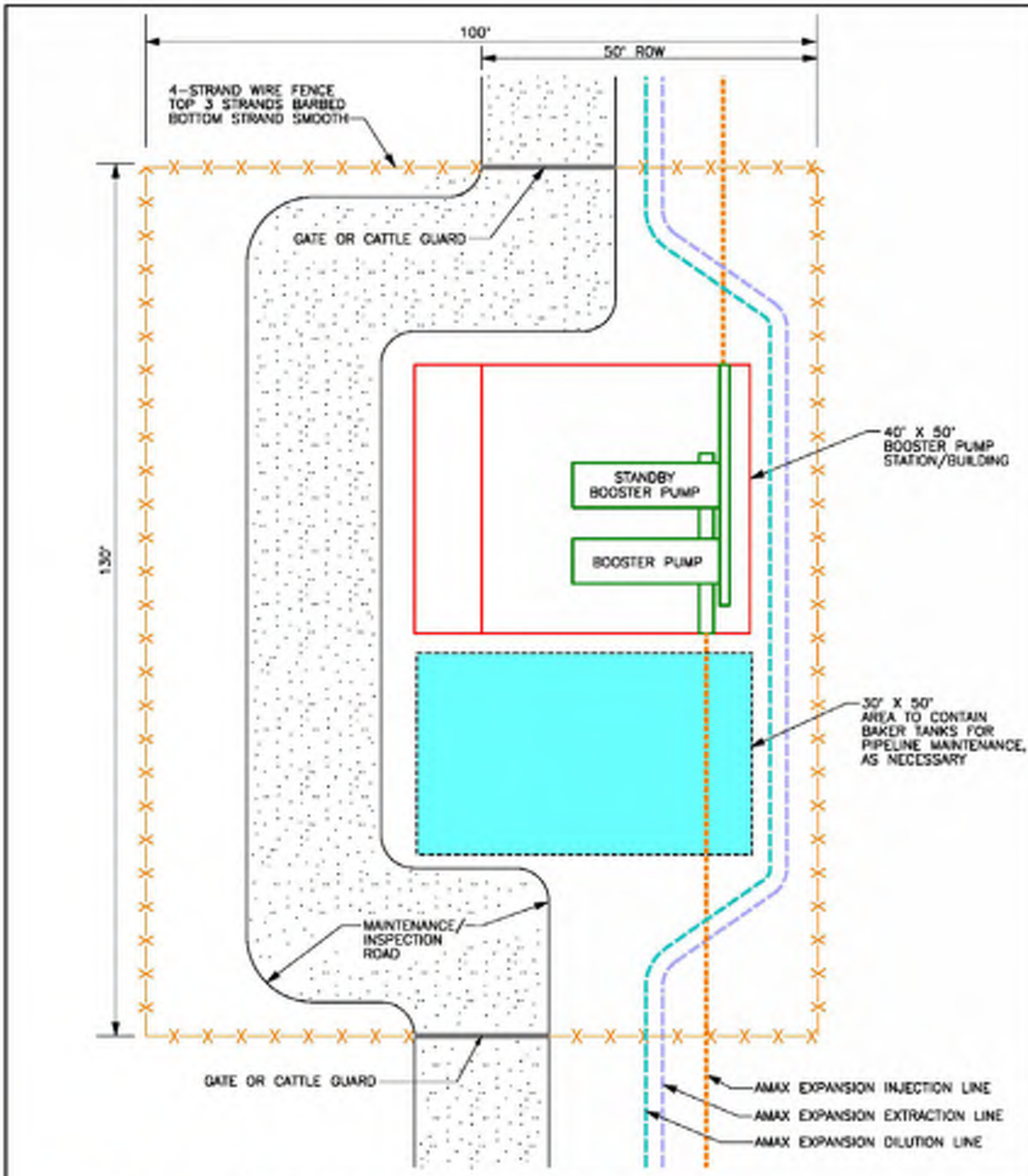
Power Distribution

Power would be required at each of the four well sites and the booster pump station. Overhead power has been previously supplied to existing extraction well IP-016 by Xcel. The same line that distributes power to IP-016 is routed immediately adjacent to the proposed booster station location. It is anticipated that Xcel would be able to modify the existing power service to support the requirements at the booster station and the only new infrastructure required may be an additional pole and associated underground service from the pole to the booster station. Central Valley Electric Cooperative (CVEC) operates an existing power line ROW located between Sections 4/5 and Sections 8 /9, T19S, R30E. New overhead power service is expected to proceed north from this existing ROW approximately ¼ mile to IP-303 along the proposed pipeline alignment and south from this existing ROW approximately ¾ mile to the south to IP-301. CVEC also operates an overhead power line in the middle of Section 11, T19S, R30E and another power ROW running immediately adjacent to IP-304. It is anticipated that the ROW adjacent in Section 11 would be extended approximately ¾ mile west to IP-302 and that the ROW to IP-304 would provide power directly to IP-304. Since the proposed power distribution is a connected action of the HB AMAX extension, the environmental analysis for the proposed power distribution is contained in this EA.

Map 3 illustrates the power ROWs and assumed distribution routes. The referenced power supply logistics above would be verified with Xcel and CVEC.

Existing Infrastructure

The existing HB Solar Solution Mine infrastructure that would be utilized with the proposed HB AMAX extension would include: groundwater supply wells, HB Mill facility, solar evaporations ponds, and portions of the existing pipeline network. Details pertaining to each of these components can be found in Section 2.4.2 of the HB EIS. Specifically, Section 2.4.2.1 details construction and layout and Section 2.4.2.2 describes the mining process.



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PREPARED BY:	RWS3	DATE: MAR.'15
REVIEWED BY:	JMH6	DATE: MAR.'15
APPROVED BY:	JMH6	DATE: MAR.'15

INTREPID POTASH - NEW MEXICO, LLC

FIGURE 6

BOOSTER PUMP SYSTEM DETAIL

Environmental Assessment
HB Solar Solution Mine – AMAX Extension

Scale: NOT TO SCALE	Date: MARCH 18, 2015
Drafted By: JOW	Project No. 14I016

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Final Restoration and Reclamation

Upon completion of solution mining activities, all above ground infrastructure associated with the proposed HB AMAX extension project would be removed and recycled or properly disposed of at a licensed off-site facility. The extraction, injection, and PTI wells would be abandoned as per state of New Mexico requirements. All sections of buried pipeline would be evacuated, flushed and abandoned in place. The power runs would be the responsibility of the utility and would be abandoned or used by other power users. Caliche and concrete pads would be removed from the well head operating areas, booster pump station area, and access road where applied. All disturbed surfaces would be graded or scarified, seeded, fertilized, and mulched as per BLM requirements. Restoration, reclamation, and financial assurance quantification of all other HB Solar Solution Mine components used separately or in conjunction with the proposed HB AMAX extension are specifically addressed in the Discharge Permit Mine Modification submittal *Discharge Permit Renewal Modification Request - HB Solar Solution Mine NMED DP-1681 – HB AMAX Extension* dated February 12, 2015.

Construction and mitigation measures for the proposed project components would be the same as those as described in the HB In-situ Solution Mine Project documents, including:

- HB In-situ Project Mine Operations and Closure Plan, Revised March 9, 2012
- HB In-situ Project Final Environmental Impact Statement, January 2012
- HB Pipeline Right-of-Way Grant, Serial Number NM-121815, April 11, 2012
- HB In-Situ Solution Mine Project Record of Decision, March 19, 2012 (HB ROD)

CARLSBAD

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DALE JANWAY
MAYOR

STEVE MCCUTCHEON
CITY ADMINISTRATOR

April 14, 2015

Jessie Hubbling
620 E. Greene St.
Carlsbad, NM 88220

575-234-5912
jhubbling@blm.gov

Dear Ms. Hubbling:

Thank you for the opportunity to comment during the scoping period for the BLM's development of an Environmental Assessment on the plan to modify Intrepid's HB Solar Solution Mine workings to include the AMAX mine in order to recover additional potash resources.

I strongly support Intrepid's proposal and believe the company's reclamation efforts associated with the HB Solar Solution Mine so far have been remarkable.

We all especially appreciate the fact that the HB AMAX Mine would provide approximately 14 years of solution mine reserves beyond the 28-year HB Solar Solution Mine life. Also, the proposal's plan to largely use existing infrastructure means that environmental impact will be minimal. The solution mining process is the same as the existing process. It is worth mentioning that the proposed extension project lies completely on potassium leases held by Intrepid and no separate Rights-of-Way (ROW) in addition to the mine modification are proposed for in this project.

The BLM should develop a new EA plan for this modification that relies heavily on existing data and current assessments obtained through the already-completed EIS. This will expedite the process and allow Intrepid to move forward with the expansion. My only other recommendation would be to make sure that the EA addresses recreational use in the area. The BLM's Hackberry OHV is highly valued by our community's desert racers.

While this is not the EA's public comment period, it is also worth noting during this scoping period that Intrepid's proposal is an extremely responsible one. The solution mining effort has been beneficial to this community. The AMAX Mine ceased production in 1993 and will now be put to good use.

We all appreciate the BLM's balanced management of public lands and appreciation of the importance of this area's potash resources.

Sincerely,

Carlsbad Mayor Dale Janway

Appendix B
Paleontological Survey Report

Intrepid Potash Pipeline Expansion Project

Paleontology Resource Survey Summary Report

Kate E. Zeigler and Peter Reser

Zeigler Geologic Consulting, LLC

February 2, 2015

Introduction

The Intrepid Potash proposed pipeline expansion corridors are located approximately 20 miles northeast of Carlsbad in sections 5, 8-11, 14-16, 21-22, 27-28 and 33-34 of T19S, R30E and sections 3 and 4 of T20S, R30E. This project will be a series of buried pipelines ranging in diameter from 4” to 18”. Portions of the proposed expansion corridors cross through areas designated as Potential Fossil Yield Categories (PFYC) 3 and 4, which necessitates pedestrian survey of the outcrop to look for potential fossil resources that may be impacted during ground disturbing activities. The outcrop exposures indicated on some geologic maps of the area show these outcrops to be Permian Rustler Formation; however, based on other geologic maps, there was also initial concern that there may have been some exposures of the Upper Triassic Chinle Formation, which sits stratigraphically above the Rustler Formation and is renowned for its vertebrate fossil record (Figure 1).

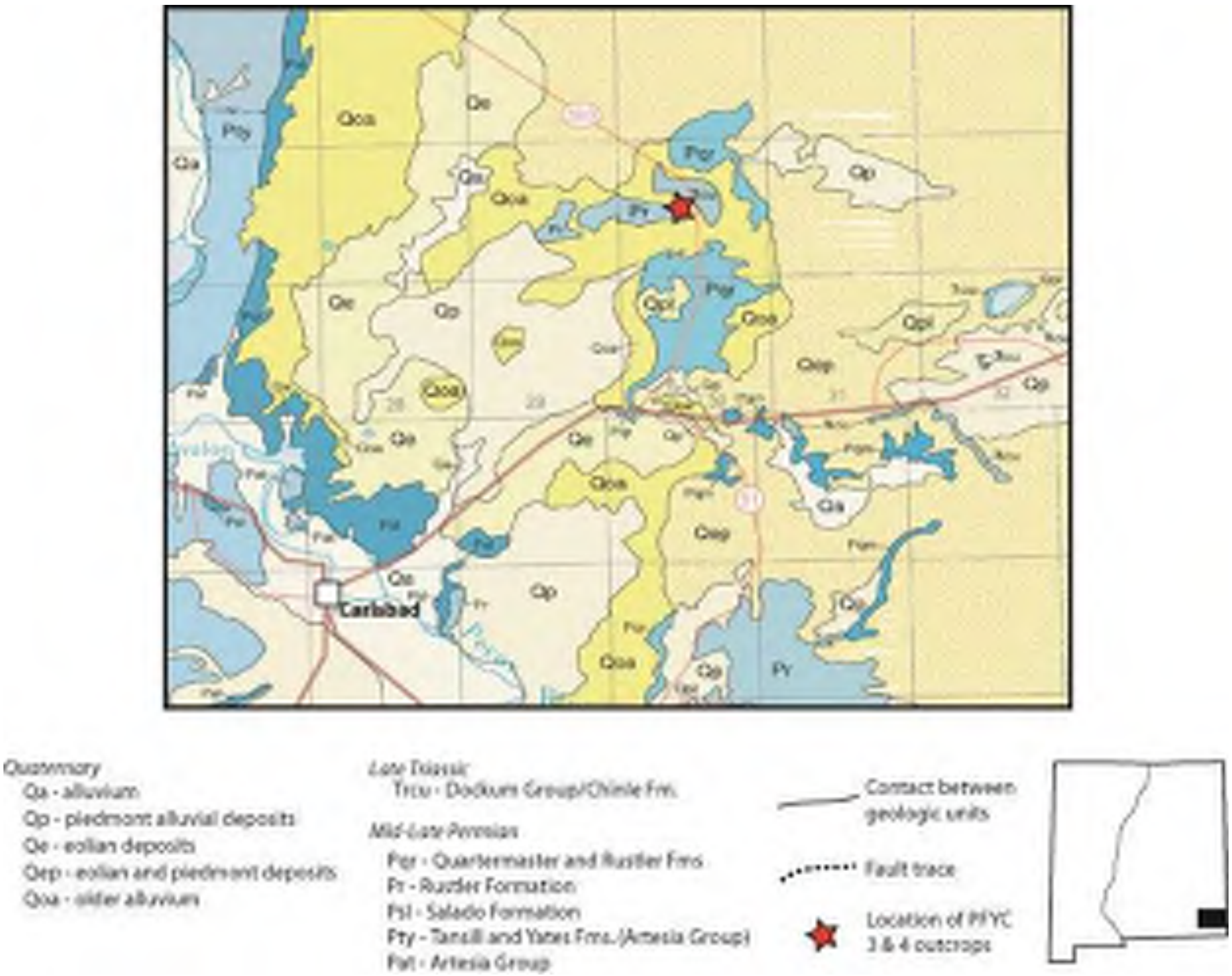

Figure 1. Regional geology of the area from Anderson and Jones (2003), showing potential Triassic Dockum Group (=Chinle Formation) outcrops.

Geologic History

Southeastern New Mexico has been the focus of a variety of different tectonic events, which are reflected not only by the different units discussed above, but also by the modern topography, as well as the vast oil and natural gas reserves of the western Permian Basin. Permian strata in the project area include the Castile, Salado and Rustler Formations (Figure 2). During the Middle Permian, the Delaware Basin of southeastern New Mexico saw maximum subsidence just prior to and during the deposition of the San Andres Formation (Kues and Giles, 2004). As deposition of the San Andres Formation ended, southeastern New Mexico was tectonically quiet and marine environments regressed to the south. The Artesia Group, deposited above the San Andres Formation, records this overall regression, but also smaller fluctuations in sealevel (Kues and Giles, 2004). These units were deposited adjacent to the massive Capitan Reef complex that developed to the south. As sealevel continued to drop through the Late Permian, the contact between normal marine and evaporite facies migrated closer to the reef complex to the south (Kues and Giles, 2004). Units deposited during this time are dominated by dolostone to the south and grade to the north into evaporites and red siliciclastics.

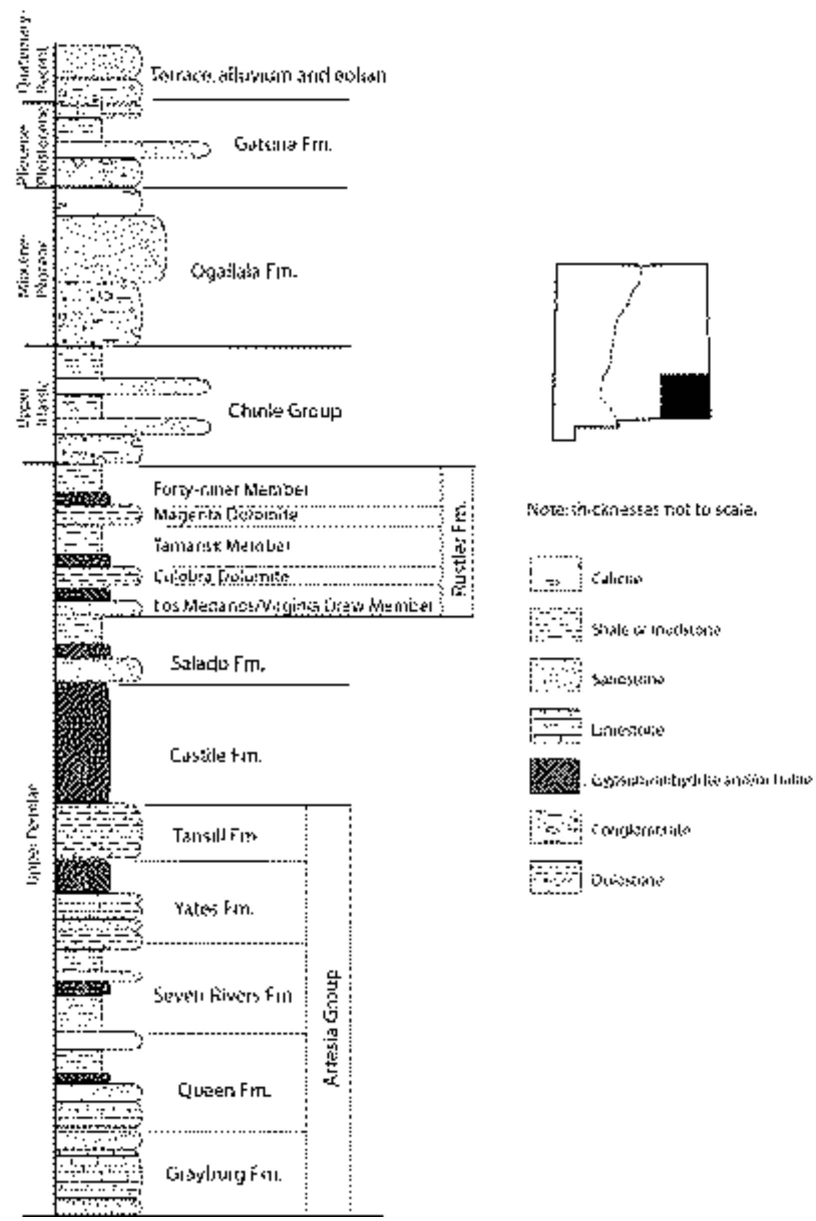

Figure 2. Regional stratigraphy for the proposed project area.

During the Late Permian, the Castile, Salado and Rustler Formations were deposited. Sealevel was continuing to regress and marine deposition was confined to the Delaware Basin in the far southeastern corner of New Mexico (Kues and Giles, 2004). Connections between the basin and the open ocean to the south became very restricted, turning most of the basin into a relatively isolated lagoon, thus causing the thick evaporite deposits of the Castile and Salado Formations (Kues and Giles, 2004). By the onset of Rustler deposition, an overall sealevel transgression had begun. This rise in sealevel brought normal marine deposition back to the region, although this return to a marine environment was interspersed with small sea level fluctuations that led to development of sabkha and mudflat environments (Kues and Giles, 2004).

Rustler Formation Sedimentology

The Rustler Formation is anywhere from 60 to 150 m in thickness with considerable variation in thickness in both outcrop and the subsurface (Vine, 1963; Kelley, 1971; Bachman, 1983; Kues and Giles, 2004). The formation is divided into five members (in ascending order): Los Medaños/Virginia Draw Member, Culebra Dolomite, Tamarisk Member, Magenta Dolomite and Forty-niner Member (Kelley, 1971; Kues and Giles, 2004; Powers and Holt, 1999; Powers et al., 2006). The lower 25-50 m of the Rustler Formation include reddish siltstone, dolostone, minor limestone and gypsum and invertebrate fossils represent normal marine fauna, as opposed to brackish water or higher salinity faunas (Kues and Giles, 2004). The Culebra Dolomite includes both normal marine and marginal marine fossils. Above this unit, the remainder of the Rustler Formation includes gypsum/anhydrite, halite and minor red siliciclastics. Both the Culebra and Magenta Dolomites are useful marker beds for this unit. The Culebra Dolomite is a brownis-gray, thin-bedded crystalline dolomite with distinctive spherical to ovoid vugs whereas the Magenta Dolomite includes couplets of anhydrite or gypsum interbedded with laminated dolomite with a light reddish-brown (or magenta) color (Kelley, 1971; Bachman, 1983).

In the southern part of the survey area, a PFYC 3 area, we observed thick anhydrite beds with very thin, pale green mudstone partings in an open trench that is part of ongoing construction on a Western Refining pipeline (Figure 3). The ground surface in the area is primarily weathered gypsum intermittently covered with eolian sheet sand deposits or small coppice dunes. Along the primary proposed expansion pipeline corridors for lines 2-INJ, 2-EXT and 4-INJ, which cross a PFYC 4 area, we observed distorted gypsum with red mudstone partings and calcrete rubble, also interspersed with eolian deposits that were locally in excess of 6 m thick (Figure 3). These areas were designated PFYC 4 but are comprised almost entirely of rock types (gypsum and calcrete) that do not preserve fossil material.

The 3-EXT corridor branches eastward to proposed well pad IP-304 and climbs a low bluff (designated PFYC 3) that includes exposures of thin gypsum beds, along with reddish brown, laminated siltstone to fine sandstone with greenish-gray mottling in places (Figure 3). The bluff is capped by a 1 to 3 m thick deeply weathered calcrete horizon that may be a relict surface related to the Miocene-Pliocene Ogallala Formation. Along the alternative expansion pipeline corridor for 2-INJ we observed the distorted gypsum with red mudstone partings and abundant eroded calcrete rubble. The interbedded gypsum and siliciclastics suggest that these outcrops may pertain to the lowest member of the Rustler Formation, the Los Medaños Member, but with a lack of exposure of dolomite beds, it is not possible to be certain of the stratigraphic position of these units.

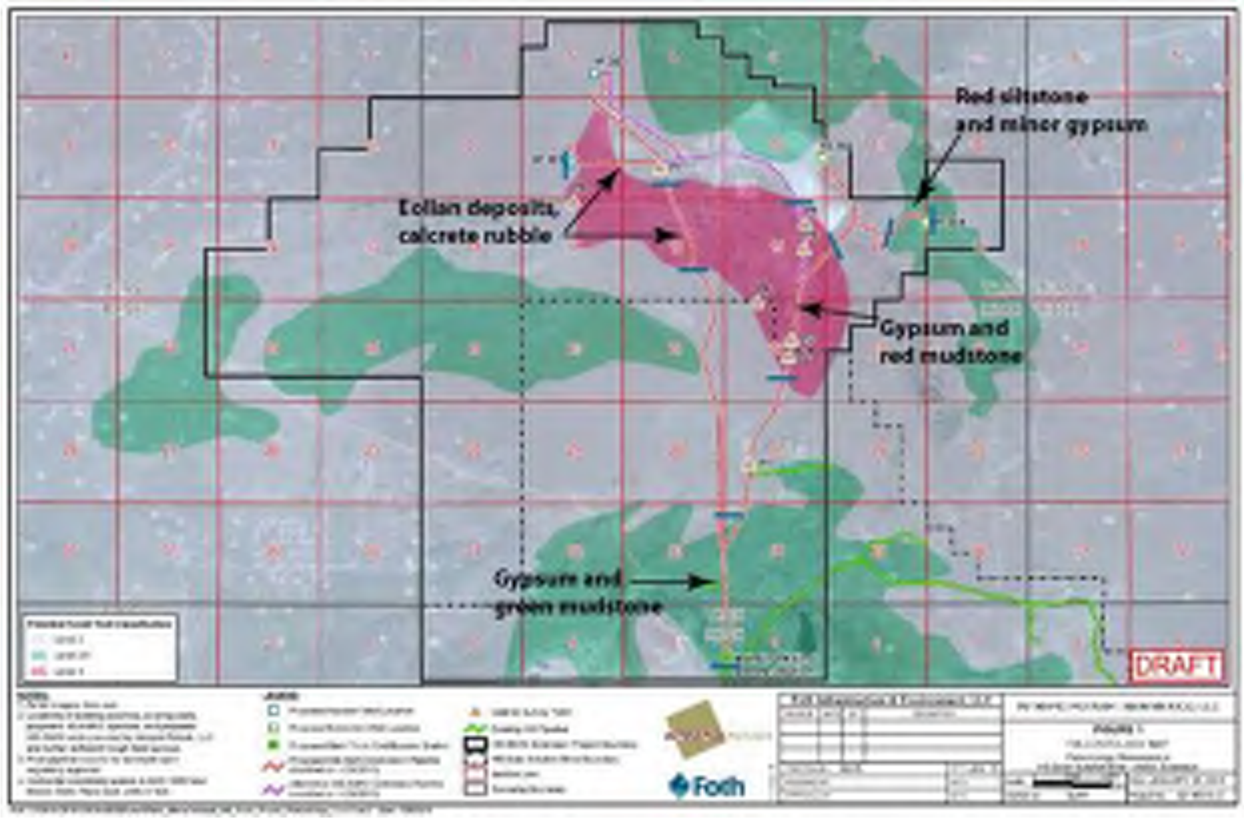

Figure 3. PFYC areas along the proposed pipeline corridors and well pad locations with local geology of the Rustler Formation.

Rustler Formation Paleontology

Few fossils have been recovered from the Rustler Formation and all of these are marine invertebrates. Macrofossils that have been reported include molluscs and brachiopods (Walter, 1953) as well as conodonts (Croft, 1978; Wardlaw and Grant, 1992). These invertebrate fossils have been useful for ascertaining the age of the Rustler Formation as being Late Permian. In general, sabkha and marginal marine environments usually do not preserve fossil material well.

Paleontology Resource Survey

On Sunday February 1, 2015, we performed pedestrian survey of outcrop exposures along the proposed corridor that crosses through the BLM-designated PFYC 3 and 4 areas. We surveyed a 150' corridor on either side of the center line stakes except where current construction for Western Refining is co-located with the proposed corridors. Much of the bedrock is partially to completely covered by eolian sheet sands or small coppice dunes. Other than the low bluff leading to the proposed well pad IP-304, outcrop exposures consisted almost entirely of distorted gypsum beds with occasional mudstone partings that are either pale green or reddish brown in color. The low bluff consists of interbedded reddish brown siltstone to sandstone and gypsum. Much of the area includes outcrop exposures and/or weathered remanents of a thin calcrete that may be related to the Ogallala Formation. We observed no fossil material in any of the PFYC 3 or 4 areas and recommend no monitoring for the majority of the proposed pipeline corridors and well pads, given that the majority of the outcrop and subcrop is gypsiferous, which will not preserved invertebrate or vertebrate fossil material. Few fossil resources are known from the Rustler Formation, making any potential discoveries of scientific significant. We recommend spot monitoring after grubbing/top soiling and after trenching through the low bluff leading to well pad IP-304 on the chance that fossil material might be uncovered during excavation activities.

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Appendix C
Groundwater Memorandum

Technical Memorandum TM-EA-002

Analysis and Applicability of the Hydrological Assessment and Groundwater Modeling Report for the HB In-Situ Solution Mine Project EIS (AECOM, 2011) to the Proposed HB AMAX Extension to the HB Solar Solution Mine

HB Solar Solution Mine
Proposed AMAX Extension
Eddy County, New Mexico

Project I.D.: 14I016

Intrepid Potash New Mexico, LLC

May 2015

Analysis and Applicability of the Hydrological Assessment and Groundwater Modeling Report for the HB In-Situ Solution Mine Project EIS (AECOM, 2011) to the Proposed HB AMAX Extension to the HB Solar Solution Mine

HB Solar Solution Mine
Proposed AMAX Extension
Eddy County, New Mexico

Project I.D.: 14I016

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May 2015

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1 Introduction

Intrepid Potash - New Mexico, LLC (IPNM) is proposing to expand the current in-situ solution mining operations involved with the extraction of potash from former underground mine facilities in the Secretary's Potash Area (SPA), Eddy County, New Mexico. The currently operating HB Solar Solution Mine is proposed to be expanded by flooding an additional underground mine complex (former AMAX workings) located immediately north of the existing operation. The expanded project area is illustrated by the heavy black line in **Figure TM-EA-002-1 - *General Infrastructure***, and the current HB Solar Solution Mine Project Area is illustrated by the dashed black line in Figure TM-EA-002-1. The strategy for the in-situ mining involves using injection wells to inject water into the abandoned underground mine cavities to dissolve sylvite from un-mined portions of the workings, followed by extraction of the pregnant brine solution via extraction wells, and evaporative concentration of potassium chloride (KCl) and sodium chloride (NaCl) via solar evaporation ponds. The HB AMAX Extension will require new extraction wells and piping but will rely on the existing HB Solar Solution Mine solar evaporation pond and processing mill components.

As part of the mine planning and permitting process for the HB Solar Solution Mine, an Environmental Impact Statement (EIS) was prepared to evaluate the impacts of those mining operations (BLM, 2012a). BLM issued approval for this project in the March 19, 2012 Record of Decision (ROD). The approved and permitted HB Solar Solution Mine includes solution mining in four former underground mine cavities largely located in Township 20S, Range 30E and Township 20S, Range 29E. Intrepid proposes to expand the project to include solution mining in the former AMAX underground workings located in the northern portion of the project area in Township 19S, Range 30E (see Figure TM-EA-002-1).

To supply make-up water for injection into the underground workings, for surface ore processing, and for general operations, Intrepid currently operates two existing well fields. One well field, referred to as the "North Rustler well field," produces water from the shallow, saline Rustler Formation and is located in the southern portion of the project area (indicated by the red rectangle in **Figure TM-EA-002-2 - *Location of the North Rustler Well Field***). The other well field, referred to as the "Caprock well field", produces water from the Ogallala Formation and is located 40 miles to the northeast of the project in Lea County, New Mexico (**Figure TM-EA-002-3 – *Location of the Caprock Well Field Relative to Project Area***).

To support evaluation of impacts resulting from groundwater extraction associated with the HB Solar Solution Mine Project (as required by the National Environmental Policy Act [NEPA]) the Carlsbad office of the Bureau of Land Management (BLM) commissioned a groundwater modeling study (*Hydrological Assessment and Groundwater Modeling Report for the HB In-Situ Solution Mine Project EIS* - AECOM, 2011). The groundwater study was, in turn, used to support the EIS process for the proposed action. The modeling study applied two separate models to evaluate impacts of groundwater withdrawals from the two well fields. One model addressed operation of the North Rustler well field wells and the other model addressed the Caprock well field.

Groundwater withdrawals from the North Rustler well field area are made from two confined aquifers within the Rustler Formation, the Magenta dolomite aquifer and the lower Culebra dolomite aquifer. The Magenta and Culebra aquifers are separated by a 40 foot (ft) thick aquitard. However, the two aquifers can be locally hydraulically connected due secondary porosity from the dissolution and collapse of underlying geologic units. Due to the complex hydrostratigraphy and variable aquifer characteristics of the Magenta and Culebra aquifers, AECOM (2011) developed a detailed numerical model for the North Rustler well field wells based on the U.S. Geological Survey MODFLOW code (McDonald and Harbaugh, 1988).

At the existing Caprock well field, groundwater is pumped from the Ogallala aquifer. The Ogallala aquifer is a sedimentary aquifer comprised of semi-consolidated deposits of gravel, sand, silt, and clay. Although the hydrogeologic characteristics of the Ogallala are spatially variable, the aquifer system is less complex than the Rustler system. Given the relative uniformity in the Ogallala, AECOM (2011) modeled the Ogallala well field using an analytical model based on the GLOW analytical element code (Haitjema Software, 2007).

AECOM used the two models to estimate the sustainable yield for each well field and the drawdown associated with the withdrawals. The project duration evaluated in the EIS modeling studies performed by AECOM involved groundwater extraction spanning 28 years (projected life of the HB Solar Solution Mine). Total groundwater withdrawal rates analyzed for the original project configuration include the following:

- Phase I (years 0 - 7), 2,267 gallons per minute (gpm)
- Phase II (years 8 - 21), 1,262 gpm
- Phase III (years 22 - 28), 208 gpm

With the addition of the HB AMAX Extension, annual water needs for the combined HB Solar Solution Mine/HB Amax Extension will not change from the original case. However, the project life has been expanded from 28 to 42 years. With the additional in-situ operations at HB AMAX under consideration, the proposed groundwater withdrawals maintain the same approximate pumping rates for each phase but expand the duration of pumping. Under the HB AMAX expansion the following timeframes and associated groundwater withdrawal rates (same as the original case) are expected:

- Phase I (years 0 - 14), 2,267 gpm
- Phase II (years 15 - 32), 1,262 gpm
- Phase III (years 33 - 42), 208 gpm

The purpose of the analysis presented herein and the opinions provided in this Technical Memorandum are to:

1. Review and summarize the model development and calibration for both the Rustler and the Caprock groundwater flow models;

2. Identify new site information which has been obtained since the AECOM (2011) models were developed and analyze the impact, if any, that the new data might have on the validity of model predictions;

3. Determine if the drawdown predictions from the two groundwater flow models developed by AECOM (2011) can be reasonably applied to the extended duration of groundwater withdrawals proposed under the AMAX expansion; and

4. Determine the merit, if any, in updating the EIS groundwater models.

2 Model Development and Calibration

The development and calibration of a groundwater flow model requires compiling available data to define the model geometry, select boundary conditions, and provide calibration targets to evaluate the model performance. The following sections discuss the methodology and data sources used to develop and calibrate the Rustler and Caprock groundwater models. The material presented below was compiled by reviewing the AECOM (2011) report and other support information provided by the BLM.

2.1 Rustler Section 2 Groundwater Flow Model

Model Geometry

AECOM (2011) developed and calibrated a well-recognized and professionally accepted groundwater flow model ("Rustler model") for the Rustler formation aquifers using the finite difference code, MODFLOW (McDonald and Harbaugh, 1988). The six layer MODFLOW model discretized a 429 square mile model domain into 1,000 x 1,000 ft grid cells with a total of 71,982 grid cells. The model domain is shown in **Figure TM-EA-002-4 – *Rustler Groundwater Model Domain***. The six model layers correlated to site stratigraphy with the following designations:

- Layer 1 = Dewey Lake Red Beds and overlying alluvial deposits
- Layer 2 = Forty Niner Member of the Rustler Formation
- Layer 3 = Magenta Dolomite Member of the Rustler Formation
- Layer 4 = Tamarisk Member of the Rustler Formation
- Layer 5 = Culebra Dolomite Member of the Rustler Formation
- Layer 6 = Los Medaños Member of the Rustler Formation

For this model the geologic units represented by Layers 2, 4, and 6 were considered aquitards. Model parameters and boundary conditions reflective of these conditions were assigned to these aquitard layers. The parameters used for these units were not varied as part of the calibration process, thus the parameter values used in Layers 2, 4, and 6 of the calibrated model were the same as those assigned at the outset of model development.

Layers 1, 3, and 5 represent aquifers. The Culebra Dolomite (Layer 5) and the Magenta Dolomite (Layer 3) of the Rustler Formation supply water to the North Rustler well field and were the main hydrogeologic units of interest. The Dewey Lake Red Bed aquifer (Layer 1) is not continuous on a regional scale but locally can produce sustainable well yields. Boundary conditions and model parameters were selected for each of these layers, as described in the sections below.

Boundary Conditions

The specification of boundary conditions is a required element in the development of a groundwater flow model; boundary conditions define the state of the groundwater system at the perimeter of the modeling domain and in some instances, at key locations on the interior of the modeling domain. Standard modeling practice calls for selecting boundary condition types and locations such that the boundary has minimal impact on simulation results in the area of interest.

Three types of boundary conditions are common in MODFLOW: specified head, specified flux, and head-dependent flux boundaries. The Rustler model used all three boundary types. Specified head boundaries were assigned to the eastern, southern, and part of the northern edge of Layers 1, 3, and 5. These boundary conditions were based on a report by Geohydrology Associates (1979) indicating groundwater flow entering or leaving the model domain in those areas.

A specified flux, no flow, boundary was assigned to the western edge of the model where groundwater flow was assumed to be parallel (north-south) to the model boundary. A no flow boundary was also assigned to the bottom of the model and represents the contact between the Rustler and relatively impermeable Salado evaporite formation.

A specified flux was assigned to the top of the model to represent groundwater recharge. Further discussion of how the recharge was estimated is provided below. An additional head-dependent flux boundary was assigned to the uppermost model layer to represent evaporative water loss resulting from groundwater discharge to springs, seeps, playas, and salt ponds. At this head-dependent boundary water is removed from the model only when the water levels rise above a threshold elevation, such as the elevation of a lakebed.

Model Parameters

The following sections outline how recharge, layer thickness, and hydraulic conductivity parameters were selected for the Rustler model.

Recharge

A constant flux recharge term was assigned to model Layer 1. Recharge is difficult to measure directly and is often a source of uncertainty in a groundwater model. For the Rustler model, the recharge rate was estimated from water balance studies (Geohydrology, 1978b and Hunter, 1985) that were conducted near the project site. Results of these studies indicated that in the project area, 96 percent (%) of precipitation evaporates, 1% is held as soil moisture, and 3% recharges the groundwater system. Additional, anthropogenic recharge is provided by seepage from tailings basins. According to Geohydrology (1978b), 3% of average rainfall for the region translates into a 0.42 inches per year (in/yr) recharge rate. The recharge rate used in the AECOM model was 0.48 in/yr and reflects recharge from precipitation as well as seepage from tailings basins.

Layer Thickness

Thickness of the model layers represents the actual thickness of hydrostratigraphic units in the model domain. Layer thickness was represented by assigning a top and a bottom elevation to each grid cell in each layer. These elevations were estimated for the Rustler model using data from boring logs. Conventional modeling techniques use boring logs to identify top and bottom elevations of a hydrostratigraphic unit. These elevation data and geographic coordinates of the borings are commonly interpolated to provide top and bottom elevations for the model grid cells. Uncertainty in this interpolation largely depends on the quality of logs available, the spatial distribution of log data, and the degree of variability in layer thickness. AECOM (2011) indicated that areas where layers thinned or pinched out were assigned a default thickness of 10 ft; this was based on a simplifying assumption of formation continuity.

Hydraulic Conductivity
Hydraulic conductivity reflects the rate at which a fluid can flow through a given porous medium. Within a single geologic unit, hydraulic conductivity can vary based on changes in the rock properties including the degree of cementation, presence of fractures, changes in grain size, etc. Estimates of hydraulic conductivity for this model came from several data sources including available literature and pumping test data from seven Intrepid wells (IP-WW-001 through IP-WW-007).

Some groundwater flow models assume homogeneity in the hydraulic conductivity field while others incorporate complex, heterogeneous distributions in conductivity. The degree to which heterogeneity is incorporated into the model should be a reflection of measured heterogeneity in the unit's hydraulic conductivity, type of rock being modeled, and general geologic knowledge of a given unit. The two aquifers of interest were fractured dolomite units. Fractured rocks can present a modeling challenge when fractures of high hydraulic conductivity are present within a low permeability rock matrix. Additionally, the location and continuity of fractures is often unknown. Hydrogeologic testing in fractured rocks can produce a wide range of hydraulic conductivity estimates depending on the proximity of the test well to individual fractures or fracture sets. AECOM (2011) treated the fractured rock as an equivalent porous media (EPM). This is a widely-used approach when fractures are relatively uniform in distribution and the scale of the model domain is large relative to fracture spacing.

Because of uncertainty in hydraulic conductivity and the possibility for heterogeneity, many groundwater models use some form of parameter optimization software to optimize a hydraulic conductivity distribution. The Rustler model used what is referred to as the pilot point method to calibrate the model with respect to hydraulic conductivity. This approach resulted in an optimized and heterogeneous distribution of hydraulic conductivity. Each pilot point was assigned a range of acceptable hydraulic conductivity values that were informed by the estimates provided in Table 1. The model calibration technique and results are discussed in greater detail below.

Table 1

Summary of Hydraulic Conductivity Estimates and Data Sources for the Rustler Model

Geologic Unit/Model Layer	Estimated Hydraulic Conductivity (ft/day)	Data Source
Dewey Lake Red Beds/Layer 1 (Intrepid Project Site)	0.77	Constant rate discharge, single well pumping test in IP-WW-007
Dewey Lake Red Beds/Layer 1 (Clayton Basin)	0.02-1.2	Water Management Consultants (1999)
Dewey Lake Red Beds/Layer 1(Overall)	***0.02-1.2***	
Magenta Dolomite/Layer 3 (Intrepid Project Site)	0.001 – 92.7	Constant rate discharge, single well pumping tests in IP-WW-001, IP-WW-003, IP-WW-004, IP-WW-005, and IP-WW-006
Magenta Dolomite/Layer 3 (WIPP Site)	3.0×10^{-5} - 2.8	U.S. Geological Survey and Sandia National Laboratories

Geologic Unit/Model Layer	Estimated Hydraulic Conductivity (ft/day)	Data Source
Magenta Dolomite/Layer 3 (Overall)	***$3.0x10^{-5}$ – 92.7***	
Culebra Dolomite/Layer 5 (Intrepid Project Site)	0.55-0.58	Constant rate discharge, single well pumping test in IP-WW-002
Culebra Dolomite/Layer 5 (General)	$6x10^{-5}$ - 56.7	Brinster (1991)
Culebra Dolomite/Layer 5 (Overall)	***$6x10^{-5}$ - 56.7***	
Rustler Formation/Layers 3 and 5 (Undivided, Clayton Basin)	0.003 - 25	Water Management Consultants (1999)

ft/day = feet per day

Prepared By: MJH
Checked By: DRD

Model Calibration

The Rustler model was calibrated using 65 hydraulic head targets for Layers 1, 3, and 5. These targets were distributed throughout the model domain (**Figure TM-EA-002-5 – *Distribution of Calibration Targets*).** Head targets were assigned using data from Geohydrology Associates (1978a and 1978b), Water Management Consultants (1999), Cooper and Glanzman (1971), Intrepid Potash Inc./Shaw (2008), and other reports from the nearby WIPP site. The dates of measurement ranged from the 1950s-2008, with the majority of available data collected in the 1970s. AECOM (2011) assumed that these head values represented equilibrium conditions that are still present today. It is known that there was some pumping, albeit minimal, that was occurring in these aquifers during the 1970s.

A pilot point method was used to calibrate the groundwater model with hydraulic conductivity as the only parameter being optimized. Using this method pilot points are scattered throughout the model domain; each point is assigned a starting parameter value and a range of acceptable values. For the pilot point calibration, the model is run repeatedly, using evolving estimates of the parameter of interest, in this case hydraulic conductivity, that provide evolving estimates of the variable of interest; hydraulic head for the Rustler model. An optimization algorithm evaluates the difference between modeled heads and known heads (the calibration targets) and uses that information to inform an improved estimate of hydraulic conductivities throughout the model domain. This process is repeated numerous times until the difference between modeled heads and known heads is within a pre-defined error tolerance. The final, calibrated hydraulic conductivity distributions for Layers 1, 3, and 5 can be seen in **Figure TM-EA-002-6 – *Distribution of Hydraulic Conductivity in the Dewey Lake Red Beds;* Figure TM-EA-002-7 – *Distribution of Hydraulic Conductivity in the Magenta Dolomite Aquifer;* and Figure TM-EA-002-8 – *Distribution of Hydraulic Conductivity in the Culebra Dolomite Aquifer*.**

Hydraulic conductivity was the only parameter calibrated in the AECOM model of the Rustler wells; layer thickness was not specifically included as a calibration parameter for this model. However, hydraulic conductivity and layer thickness are coupled in the governing groundwater equation used by MODFLOW. Together, thickness and hydraulic conductivity are used to calculate a transmissivity. Because hydraulic conductivity was used as a calibration parameter and thickness was not, and because the MODFLOW calculations are based on the product of hydraulic conductivity and thickness, the calibrated hydraulic conductivity values may be influenced by variations and uncertainty in both unit thickness and hydraulic conductivity. For example, in areas where the estimated layer thickness is too thin, the transmissivity will be too low. The calibration process in this scenario is likely to yield an elevated hydraulic conductivity resulting from the code's attempt to increase transmissivity. The effective transmissivity in this case may approach the correct value, but the estimated hydraulic conductivity could be substantially greater than the actual.

The result of this methodology is that the calibrated hydraulic conductivity values may be influenced by interpretations of layer thickness. However, the ability to compensate for errors in layer thicknesses by adjusting hydraulic conductivity partially nullifies the problem of not knowing the exact layer thickness at each grid cell. Therefore, not knowing small variations in layer thickness may become irrelevant as long as the modeler is comfortable with a hydraulic conductivity distribution that has two sources of deviation from actual field conditions, one derived from the layer thickness and the other from the actual hydraulic conductivity field. Understanding the limitations of this calibrated hydraulic conductivity distribution becomes important when new hydraulic conductivity estimates are compared to the modeled distributions, as done in Section 2.3 of this Technical Memorandum.

Preferred and Enhanced Rustler Models

The calibrated Rustler model discussed above was termed "the preferred model." Because some aquifer tests performed on wells in the North Rustler well field area and actual observed production well discharge rates indicated potentially higher hydraulic conductivities in the Magenta and Culebra aquifers (associated with fracturing surrounding breccia pipes), a second version of the model was constructed. This model, termed "the enhanced model", incorporated higher hydraulic conductivities in the Magenta model layer in the vicinity of the North Rustler well filed and to the north. This enhanced hydraulic conductivity distribution for the Magenta layer can be seen in **Figure TM-EA-002-9 – *Distribution of Hydraulic Conductivity in the Magenta Dolomite Aquifer – Enhanced Model***.

2.2 Caprock Groundwater Flow Model

AECOM (2011) developed and calibrated an analytical element model for the Caprock wells in the Ogallala aquifer using the GFLOW code (Haitjema Software, 2007). Unlike the numerical model used for the Rustler well field, an analytical model is less sophisticated and requires the modeler to make several simplifying assumptions about a groundwater system. Analytical models perform best in simple aquifer systems with low heterogeneity. Compared to the Rustler aquifers, the Ogallala aquifer is a much more prolific, homogeneous, and less complex system. The Ogallala aquifer is composed of relatively continuous hydrostratigraphy and generally lacks the spatial variation of hydraulic conductivity.

The Caprock model domain covered Intrepid' s HB and East Caprock well fields, an area with a 10-mile radius centered near Buckeye, NM (**Figure TM-EA-002-10 – *Model Domain for the Caprock Analytical Model***). This two dimensional, single layer, steady state model used the parameters shown in Table 2. All parameters were estimated using information provided by the New Mexico Office of the State Engineer, McAda (1984), and Musharrafieh and Chudnoff (1999). Heterogeneity in the transmissivity was introduced by changing the saturated aquifer thickness at various locations.

Table 2

Model Parameters for the Caprock Analytical Model

Parameter	Value
Saturated Thickness	120 – 180 ft
Hydraulic Conductivity	15 – 32 ft/day
Transmissivity	3,000-3,200 ft^2/day
Porosity	0.2
Recharge	0.49 inches/year

Prepared By: MJH
Checked By: DRD

The model was calibrated using 35 hydraulic head values estimated from a map of measured and estimated groundwater elevations (Tillery, 2008). The calibration involved manually adjusting hydraulic conductivities and aquifer bottom elevations until differences between observed and simulated groundwater elevations were minimized.

2.3 Additional Data

Since the modeling effort, Intrepid has installed 41 new well locations within the Rustler model domain. Pilot, testing and instrument (PTI) wells are immediately adjacent to either a water supply well, extraction well, or injection well; the PTI well and its adjacent operational well were considered a single, new data source. The locations of these wells are displayed in **Figure TM-EA-002-11 – *Current HB Solar Solution Mine Monitoring Well Network*** and **Figure TM-EA-002-12 – *Current HB Solar Solution Mine Operational Components***. Figure TM-EA-002-11 shows all the monitoring wells and Figure TM-EA-002-12 shows the production, injection, extraction, and PTI wells. No new well locations were added by Intrepid in the Caprock model domain, accordingly no new information is available for the Caprock well field and this additional data discussion will focus solely on new data for the Rustler models. Table 3 summarizes the available data for each of the Intrepid wells. Available data includes boring logs, geophysical logs, pump test data, time series water level data from pressure transducers, and quarterly manual water level measurements. Of the wells shown in Table 3, the Rustler model only used information from Intrepid wells IP-WW-001 through IP-WW-007. Estimates of hydraulic conductivity from the pumping tests are shown in Table 4.

Table 3

Summary of Available Data from Intrepid Wells

Well Name	Well Type	Boring Log	Geophysical Log	Pump Test Data	Quarterly Water Level Data	Pressure Transducer Data (Date Range, Sample Interval)
IP-SWW-021C	Monitoring Well	x	x	x	x	6/26/12 - 1/14/14, 5 minute
IP-SWW-021M	Monitoring Well	x			x	
IP-SWW-022D	Monitoring Well	x	x	x	x	
IP-SWW-022G	Monitoring Well	x		x	x	6/26/12 - 1/14/14, 5 minute
IP-SWW-023C	Monitoring Well	x	x	x	x	
IP-SWW-023M	Monitoring Well	x		x	x	6/26/12 - 2/19/14, 5 minute

Well Name	Well Type	Boring Log	Geophysical Log	Pump Test Data	Quarterly Water Level Data	Pressure Transducer Data (Date Range, Sample Interval)
IP-SWW-024M	Monitoring Well	x		x	x	
IP-SWW-025C	Monitoring Well	x	x	x	x	6/26/12 - 2/18/14, 5 minute
IP-SWW-026M	Monitoring Well	x	x	x	x	
IP-SWW-028M	Monitoring Well	x	x	x	x	
IP-SWW-029M	Monitoring Well	x	x	x	x	6/26/12 - 2/18/14, 5 minute
IP-SWW-030A	Monitoring Well	x		x	x	
IP-SWW-030C	Monitoring Well	x		x	x	
IP-WW-001	Monitoring Well	x	x	x	x	
IP-WW-002	Monitoring Well	x	x	x	x	7/21/12-7/22/12, 5 minute
IP-WW-003	Monitoring Well	x	x	x	x	
IP-WW-004	Monitoring Well	x	x	x	x	
IP-WW-005	Monitoring Well	x	x	x	x	
IP-WW-006	Monitoring Well	x	x	x	x	
IP-WW-007	Monitoring Well	x		x	x	
IP-WW-008	Monitoring Well	x			x	
IP-WW-009	Monitoring Well	x			x	
IP-WW-010	Monitoring Well	x			x	
WW-11	Monitoring Well	x	x			
WW-12	Monitoring Well	x	x			
WW-13	Monitoring Well	x	x			
WW-14	Monitoring Well	x	x			
IP-015	Injection Well	x	x			
IP-016	Extraction Well	x	x			
IP-PTI-016	PTI	x	x			
IP-017	Injection Well	x	x			
IP-018	Injection Well	x	x			
IP-019	Injection Well	x	x			
IP-020	Extraction Well	x	x			
IP-PTI-020	PTI	x	x			
IP-021	Extraction Well	x	x			
IP-022	Injection Well	x	x			
IP-024	Extraction Well	x	x			
IP-025	Extraction Well	x	x			
IP-028	Extraction Well	x	x			
IP-PTI-028	PTI	x	x			
IP-029	Injection Well	x	x			
IP-030	Extraction Well	x	x			
IP-PTI-030	PTI	x	x			
IP-031	Injection Well	x				
IP-WS-001	Rustler Water Supply Well	x	x			6/26/12-7/17/12; 5 minute
IP-WS-002	Rustler Water Supply Well	x				7/31/12 - 8/1/12; 5 minute
IP-WS-003	Rustler Water Supply Well	x				
IP-WS-004	Rustler Water Supply Well	x				

Well Name	Well Type	Boring Log	Geophysical Log	Pump Test Data	Quarterly Water Level Data	Pressure Transducer Data (Date Range, Sample Interval)
IP-WS-005	Rustler Water Supply Well		x			
IP-WS-006	Rustler Water Supply Well					
IP-WS-007	Rustler Water Supply Well					
IP-PTI-001m	PTI	x				
IP-PTI-002m	PTI	x				
IP-PTI-002c	PTI	x				
IP-PTI-003m	PTI	x				7/12/12-7/31/12; 5 min
IP-PTI-003c	PTI	x	x			
IP-PTI-004m	PTI	x	x	x		
IP-PTI-004c	PTI	x				
IP-PTI-005	PTI		x			
IP-PTI-006	PTI		x			

Notes
1. The PTI wells are pilot, instrument, testing, and instrument wells.
2. The quarterly water levels were measured between 3/2012 and 11/2014 for the IP-SWW-### wells. The water levels were measured between 3/2007 and 11/2014 for wells IP-WW-001 through IP-WW-007 wells. The water levels were measured between 4/2009 and 11/2014 for wells IP-WW-008 through IP-11-010.

Prepared By: MJH5
Checked By: DRD

Table 4

Pump Test Data

Well Name	Screened In	Pump Test Type	Solution Method	Estimated Transmissivity (ft^2/min)	Hydraulic Conductivity (ft/day)
IP-SWW-030A	Alluvium	Single Well	Cooper-Jacob	0.18	7.1
IP-SWW-021C	Culebra	Single Well	Cooper-Jacob	1	72.0
IP-SWW-023C	Culebra	Single Well	Cooper-Jacob	1.54	170.0
IP-SWW-025C	Culebra	Single Well	N/A	N/A	N/A
IP-SWW-030C	Culebra	Single Well	N/A	N/A	N/A
IP-SWW-022D	Dewey Lake	Single Well	Cooper-Jacob	0.17	1.8
IP-SWW-022G	Gatuña	Single Well	Cooper-Jacob	0.12	3.0
IP-SWW-023M	Magenta	Single Well	N/A	N/A	N/A
IP-SWW-024M	Magenta	Single Well	Cooper-Jacob	1	96.0
IP-SWW-026M	Magenta	Single Well	Cooper-Jacob	0.79	40.6
IP-SWW-028M	Magenta	Single Well	N/A	N/A	N/A
IP-SWW-029M	Magenta	Single Well	N/A	N/A	N/A
IP-WS-004	Magenta	Single Well	Gringarten	N/A	16.1

Notes
1. All tests were done using a single well pumped at a constant pumping rate.
2. Wells with “N/A” did not have reliable pump test results.

Prepared By: MJH5
Checked By: DRD

The new boring data from the Intrepid wells may improve the estimated layer thicknesses for the Rustler model. Layer thicknesses from the Intrepid borings were compared to the thicknesses from the IP-WW wells (1 through 7) that were used in the development of the Rustler model (Table 5). Modeled thicknesses were generally similar to the ranges observed in the new well data. The largest thickness differences were seen in Layer 1, with new well data having a lower end member for the range of values.

Table 5

Comparison of Modeled Layer Thicknesses and New Layer Thickness Data

Data Source	Layer 1 Thickness (ft)	Layer 2 Thickness (ft)	Layer 3 Thickness (ft)
Range from New Well Data[4]	49-501	10-29	12-30
Range from Model Data[5]	184-398	29-37	24

Notes
1. Layer 1 includes unconsolidated quaternary material, the Gatuña Formation, the Dewey Lake Red Beds, and Caliche.
2. Layer 2 is the Magenta aquifer.
3. Layer 3 is the Culebra aquifer.
4. New well data includes all Intrepid wells that were not considered for the original model.
5. Model data are the thickness from Intrepid wells IP-WW-001 through 007.

Prepared By: MJH5
Checked By: RWS3

Because the Rustler model varied hydraulic conductivity during the model calibration and because MODFLOW uses transmissivity (layer thickness multiplied by hydraulic conductivity), the calibrated hydraulic conductivity field has already compensated for some uncertainty in layer thickness (as discussed in the Rustler Model Calibration Section). The additional borehole data would likely improve the interpolated layer thicknesses. However, since the governing model equations use transmissivity (saturated thickness multiplied by hydraulic conductivity), improvements in the thickness layer of the model are offset by and already compensated for by the hydraulic conductivity assignment and iterative calibration. It is not anticipated that the additional boring data would materially improve the model results.

The impact of additional hydraulic conductivity data depends on how these data compare to the range of acceptable values used for the pilot point calibration. The Dewey Lake Red Beds, the discontinuous Gatuña Formation (a poorly consolidated, tertiary alluvial deposit), and quaternary alluvium were all lumped into Layer 1 of the Rustler model. The estimated hydraulic conductivities for these units, based on the new pumping test data, range from 1.8-7.1 ft/day. These new estimates are within the range of calibrated hydraulic conductivities (Figure TM-EA-002-6) for Layer 1 (<1.0 – 20.7 ft/day). The new estimates for the Culebra (72 ft/day and 170 ft/day) are higher than the calibrated hydraulic conductivities (Figure TM-EA-002-8) for the Culebra aquifer (<1 – 22 ft/day). The new estimates for the Magenta (16.1 ft/day, 40.6 ft/day, and 96 ft/day) are within and reflect the distribution observed in the calibrated hydraulic conductivity range (<1 – 177.3 ft/day) for the Magenta aquifer (Figure TM-EA-002-7).

Including these new hydraulic conductivity data in the groundwater model are not expected to have a substantial impact for Layer 1 (Dewey Lake Red Beds, Gatuña Formation, and unconsolidated quaternary material) and Layer 2 (the Magenta aquifer) because these data fall within the calibrated range of hydraulic conductivity values. The high hydraulic conductivity values observed in the Culebra aquifer reflect known, localized karst features which exhibit direct hydraulic communication between the Magenta and Culebra aquifers. At the project site these high conductivity karst features are surrounded by solid bedrock with a much lower hydraulic conductivity. Single well pumping tests reflect local variability in hydraulic conductivity. If a well intersects a fracture, the pump tests results would estimate a high hydraulic conductivity but that conductivity is only applicable for rock containing that fracture; the bedrock adjacent to that fracture would have a much lower conductivity value. In the groundwater model a single hydraulic conductivity value was applied to each grid cell. The model grid cells are 1,000 ft x 1,000 ft and reflect the average hydraulic conductivity over a large area, including both fractures and low permeability bedrock. The hydraulic conductivity used in a grid cell is, therefore, lower than the hydraulic conductivity observed in a single fracture or karst feature. Consequently, it is not surprising that the additional hydraulic conductivity values for the Culebra aquifer, as measured near known karst features, are above the values used in the model grid cells.

The Magenta aquifer typically exhibits higher hydraulic conductivity than the Culebra in the Clayton Basin area, as witnessed by observations during production well drilling and pump test results. This hydraulic conductivity distribution is accounted for by the pilot point calibration in the AECOM model. The pre-calibration hydraulic conductivity distribution could be updated using recent aquifer testing values. However, the overall conductivity distribution still must be extrapolated over the spatial domain of the model where natural conditions exhibit a high degree of heterogeneity due to the fractured rock aquifer characteristics. Using a calibration technique such as the pilot point method (which was employed in the AECOM modeling effort) is still the best approach for estimating the hydraulic conductivity distribution for this groundwater system.

It should be noted that neither new estimates for recharge nor better boundary condition data are available since the AECOM (2011) modeling effort. The values used by AECOM (2011) are likely still the best estimates for these boundary conditions.

2.4 Model Results from the Initial Proposed Action and Applicability to Extended Pumping Durations

In the original model analysis for the EIS (BLM, 2012a), pumping impacts were evaluated under two scenarios (Alternative A and Alternative B) for both the preferred and enhanced Rustler models as well as the Caprock model. Under Alternative A, all injection make-up water is pumped from Rustler wells (Section 2 and PCA wells located at the former PCA facility) and water for the refinery is pumped from the Caprock wells. Under Alternative B, injection make-up water is pumped from both the North Rustler well field wells and the Caprock wells; no water is pumped from the PCA wells. The BLM ROD (March 19, 2012) was based on Alternative B and actual water use today as well as proposed water use during the HB AMAX expansion is reflected by Alternative B (BLM, 2012b). Therefore, only Alternative B will be discussed in this Technical Memorandum; Alternative A is no longer applicable. The pumping rates modeled during the EIS for Alternative B are summarized in Table 6 (preferred model – lower hydraulic conductivity values) and Table 7 (enhanced model – higher hydraulic conductivity values). As discussed earlier, the pumping rates proposed for the combined HB Solar Solution Mine and HB AMAX Extension are the same as those modeled to support the EIS analysis for the HB Solar Solution Mine. The proposed pumping rates under the HB AMAX Extension are summarized in Tables 8 and 9.

Table 6

Analyzed Pumping Rates for EIS Alternative B, Preferred Rustler Model

Project Phase	North Rustler Well Field Combined Pumping Rate (gpm)	Caprock Wells Combined Pumping Rate (gpm)	Total Pumping Rate (gpm)
Phase I (yr 0-7)	177	2,090	2,267
Phase II (yr 8-21)	177	1,085	1,262
Phase III (yr 22-28)	0	208	208

Prepared By: MJH
Checked By: DRD

Table 7

Analyzed Pumping Rates for EIS Alternative B, Enhanced Rustler Model

Project Phase	North Rustler Well Field Combined Pumping Rate (gpm)	Caprock Wells Combined Pumping Rate (gpm)	Total Pumping Rate (gpm)
Phase I (yr 0-7)	670	1,597	2,267
Phase II (yr 8-21)	670	592	1,262
Phase III (yr 22-28)	0	208	208

Prepared By: MJH
Checked By: DRD

Table 8

Pumping Schedule for Project Including HB Amax Extension, Preferred Rustler Model

Project Phase	North Rustler Well Field Combined Pumping Rate (gpm)	Caprock Wells Combined Pumping Rate for Injectate (gpm)	Caprock Well Field Pumping Rate for Mill Water (gpm)	Total Caprock Pumping Rate (gpm)	Total Project Pumping Rate (gpm)
Phase I (yr 0-14)	177	1,882	208	2,090	2,267
Phase II (yr 15-32)	177	877	208	1,085	1,262
Phase III (yr 33-42)	0	0	208	208	208

Prepared By: MJH
Checked By: DRD

Table 9

Pumping Schedule for Project Including HB Amax Extension, Enhanced Rustler Model

Project Phase	North Rustler Well Field Combined Pumping Rate (gpm)	Caprock Wells Combined Pumping Rate for Injectate (gpm)	Caprock Well Field Pumping Rate for Mill Water (gpm)	Total Caprock Pumping Rate (gpm)	Total Project Pumping Rate (gpm)
Phase I (yr 0-14)	670	1,389	208	1,597	2,267
Phase II (yr 15-32)	670	384	208	592	1,262
Phase III (yr 33-42)	0	0	208	208	208

Prepared By: MJH
Checked By: DRD

Drawdown predictions were made using the Caprock and Rustler models used to support the EIS process. In both the preferred and enhanced Rustler models, water supply wells for the project were simulated as pumping from only the Magenta aquifer, although the wells are actually screened in both the Magenta and Culebra aquifers. This discrepancy results in model under-estimates of well sustainable pumping rates and over-estimates of drawdown associated with well pumping.

Drawdown in the Magenta Member of the Rustler Formation

The pumping rate reported in Table 6 for the Rustler well field is the sustainable pumping rate for this aquifer, as determined from the preferred model. A sustainable pumping rate was determined by iteratively running the Rustler model in steady state mode at a range of different pumping rates (AECOM, 2011). The goal was to determine the pumping rate which would allow a convergent, steady state solution that did not reduce water levels in the pumping wells below a point defined as 10 ft above the bottom of the Magenta aquifer. A steady state, sustainable pumping rate of 177 gpm was obtained from this simulation for the North Rustler well field wells using the preferred model; a value of 670 gpm was obtained using the enhanced model.

Resulting drawdown for the Rustler preferred model using the 177 gpm sustainable pumping rate is shown in **Figure TM-EA-002-13 – *Rustler Preferred Model Predicted Drawdown, Alternative B*** and for the enhanced model (670 gpm) in **Figure TM-EA-002-16 – *Rustler Enhanced Model Predicted Drawdown, Alternative B***. Figure TM-EA-002-16 shows that the maximum drawdown for the enhanced Rustler model is essentially the same as that estimated using the preferred model (Figure TM-EA-002-13), but the areal extent of the drawdown cone-of-depression is increased as a result of assigning a pumping rate of 670 gpm versus the 177 gpm evaluated in the preferred model. Note, in both the enhanced and preferred models the combined pumping rate from the North Rustler well field does not equal or exceed the desired production rate of 2,267 gpm needed for use as injectate. The balance of water required for the project (2,090 or 1,597 gpm for the injectate make-up water and mill – from the preferred or enhanced model respectively) must be obtained from the Caprock well field or other non-Rustler sources, as outlined in Tables 6 and 7.

Drawdown in the Ogallala Aquifers

Similar to the numerical simulation of the Rustler formation wells, the Caprock well fields were analyzed (AECOM, 2011) by conducting a steady state simulation of pumping. Unlike the Rustler models a sustainable pumping rate was not evaluated for the Caprock model; the model was run using pumping rates defined as total project water demand less water available from pumping the Rustler wells at the sustainable pumping rates, as outlined in Tables 6 and 7. A sustainable pumping rate analysis was not needed based on the long-term historical pumping record and known capacity of the Caprock well fields. As described in the EIS (Section 4.3.6.2), the Caprock well fields could supply all project water based on the Caprock model (AECOM, 2011). Intrepid owns adequate water rights to supply the maximum amount of water required for both the HB Solar Solution Mine and the HB AMAX Extension. Because the analytical model does not allow for transient pumping rates, the Caprock model was run four separate times using four different pumping rates for the well field. The first two rates correspond to the preferred Rustler model scenario (Table 6), where the sustainable Rustler pumping rate is 177 gpm and the second two pumping rates correspond to the enhanced Rustler model scenario (Table 7), where the sustainable Rustler pumping rate is 670 gpm.

The first pumping rate analyzed was 2,090 gpm, corresponding to the pumping rate for the Caprock system during Phase I if the Rustler wells were pumped at 177 gpm. The second rate analyzed was 1,117 gpm, a time-weighted average of the Phase 1, II, and III Caprock pumping rates if the Rustler wells were pumped at 177 gpm. The third rate analyzed was 1,597 gpm, representing the total Phase I Caprock pumping rate minus 670 gpm (the enhanced Rustler model sustainable pumping rate). The fourth rate analyzed was 747 gpm, the time-weighted average of the Phase I, II, and III Caprock pumping rates from Table 7, assuming a sustainable pumping rate of 670 gpm from the Rustler wells.

Analyzing the Phase I Caprock rate of 2,090 gpm resulted in the predicted drawdown depicted in **Figure TM-EA-002-14 - *Caprock Model Predicted Drawdown Alternative B, Pumping Rate = 2,090 gpm*.** Figure TM-EA-002-14 shows that the maximum additional drawdown (beyond that already present from historic pumping in the area) created by Phase I operation (2,090 gpm) of the Caprock well field is 30 to 50 ft during initial Phase 1 pumping. Analyzing the time-weighted average of the Caprock Phase I, II, and III pumping rates (1,117 gpm) resulted in the predicted drawdown depicted in **Figure TM-EA-002-15 - *Caprock Model Predicted Drawdown Alternative B, Pumping Rate = 1,117 gpm***. Figure TM-EA-002-15 shows that drawdown increases beyond that already present from historic pumping are in the range of 20 to 25 ft over the life of the project. Analyzing the Phase I Caprock rate of 1,597 gpm resulted in the predicted drawdown depicted in **Figure TM-EA-002-17 – *Caprock Model Predicted Drawdown Alternative B, Pumping Rate = 1,597 gpm***. The maximum increase in drawdown beyond that from historic pumping is 46 ft when the wells are pumped at a rate of 1,597 gpm. Analyzing the Phase I Caprock rate of 747 gpm resulted in the predicted drawdown in the range of 15 to 20 ft depicted in **Figure TM-EA-002-18 - *Caprock Model Predicted Drawdown Alternative B, Pumping Rate = 747 gpm***.

Model Applicability to the HB AMAX Extension

The proposed expansion of the HB Solar Solution Mine to include HB AMAX has raised the question of whether or not the modeling completed by AECOM (2011) can still be relied upon for evaluation of future drawdown impacts on the Rustler formation and Ogallala aquifers.

All of the pumping scenarios for both the Rustler models and the Caprock model were run using a steady state simulation. Predicted drawdowns obtained from a steady state analysis are not estimates of the drawdown at any particular phase or point in time; rather, they are estimates of the drawdown that would occur if the wells were pumped at the assigned rates in perpetuity. The point at which such equilibrium drawdown is reached could occur within Phase I, II, III or some point in time beyond Phase III. Therefore, these drawdown predictions are not projected drawdowns of any given project year; rather, they are estimates of the maximum drawdown expected if the well field were operated at the given pumping rates in perpetuity. The point in time at which this equilibrium drawdown would occur is not provided by the steady state models. However, to the extent the models provide a reasonable simulation of the Rustler and Caprock systems, the drawdown shown on Figures TM-EA-002-13 through TM-EA-002-18 will be the maximum expected at any point in the operation of the project. As previously described, several other factors such as the assumption of EPM throughout the model domain and only modeling groundwater withdrawal from the Magenta aquifer further add conservancy to the drawdown extent and well pumping capacity results.

Therefore, because these were steady states models, this modeling effort remains applicable to the extended pumping durations proposed for the HB AMAX Extension, assuming no changes to the modeled pumping rates. Predicted pumping rates for the AMAX Extension are scheduled to be the same as those analyzed for the original HB Solar Solution Mine, as shown in Table 8 (preferred Rustler model) and Table 9 (enhanced Rustler model); the Rustler sustainable pumping rates are projected to be the same. These projected pumping rates over a longer period of time means that the drawdown predicted for the Caprock well field in the EIS will be the same as the drawdown the model would predict for the new pumping schedule. Under the extended pumping schedule and the sustainable pumping rate from the preferred Rustler model (Table 8), the time-weighted average pumping rate for the Caprock wells is 1,211 gpm; is the same as the time-weighted average of 1,117 gpm shown in Figure TM-EA-002-15. Under the extended pumping schedule and the sustainable pumping rate from the enhanced Rustler model (Table 9), the time-weighted average pumping rate for the Caprock wells is 836 gpm; again the same as the time-weighted average of 747 gpm shown in Figure TM-EA-002-18 and analyzed in the EIS. The net effect of the projected pumping rates over a longer period of time would result in the same drawdown extent and depth as analyzed in the EIS. Again, this pumping schedule does not change the sustainable pumping rates for the North Rustler well field; model predictions for the Rustler aquifer are still applicable.

Since completion of the EIS, Rustler production wells WS-001, 002, 003, and 004 have been installed, equipped with pumps, and have been used for several years. The combined pumping rate has exceeded 1,800 gpm and is currently pumping at approximately 1,000 gpm (versus the simulated sustainable pumping rates of either 177 gpm or 670 gpm predicted by the Rustler models) and the associated March 2014 drawdown is significantly less than the drawdown predicted by the AECOM model as shown in **Figure TM-EA-002-19 – *Predicted and Observed Drawdown, March 2014***. The pumping rates and drawdown may further change, until steady state is achieved but based on observed water levels, drawdown may be less than the model results indicate. Sustainable pumping rates are also expected to continue to be appreciably higher than the model predicted. The most recent pumping yields and associated drawdowns from WS-002 and WS-003 indicate that pumping rates and corresponding well drawdown in the pumping wells has stabilized and may be approaching a steady state condition. These observed sustainable pumping rates in the Rustler aquifer suggest that the current model does not accurately represent site conditions to date. This discrepancy could be due to either the model hydraulic conductivity or the storativity being too low. Without new data to better estimate these terms, the modeled values cannot be improved and the modeling approach used is still the best available prediction. However, the EIS and associated analysis were inherently designed to be highly conservative in order to evaluate impacts from groundwater pumping and to develop mitigation measure to protect natural resources and it is not surprising that actual pumping rates are higher and drawdown is less than predicted.

Moving forward, an adaptive monitoring strategy of continued drawdown observations is likely the best method for identifying and mitigating actual impacts. As required by the ROD, Intrepid has established a comprehensive groundwater monitoring network (Figure TM-EA-002-11) and conducts regular monitoring to measure actual groundwater elevations throughout the project area. The primary concerns with drawdown of groundwater is the potential effect on groundwater levels in caves and karsts to the west of the project area (Macha, Banded Pit, and Skylite) and on impacts to other Rustler water users. The position of intermediate monitoring wells between the North Rustler well field and the monitored cave and karst areas allows measurement and evaluation of drawdown well before potential drawdown would occur at the monitored cave and karst sites and serves as an "early warning system". Using this system, adaptive measures can be considered prior to seeing unacceptable drawdown in groundwater levels in monitored caves and karsts. As the actual groundwater elevations are significantly higher than the modeled extent and drawdowns have not extended beyond the immediate North Rustler well field area, no reductions in pumping have been considered to date. Based on the observed data and considering the conservative model design, it is extremely unlikely that the actual observed drawdowns will exceed the model predictions for the existing HB Solar Solution Mine operation and with the addition of the proposed HB AMAX Extension.

3 Conclusions

The AECOM (2011) numerical and analytical models have been calibrated and incorporated into the final EIS (BLM, 2012a). Both the numerical and analytical models used steady state simulations to estimate equilibrium drawdown for a variety of pumping rates in the Rustler and Caprock well fields. The Amax expansion project uses rates that in all instances are equal to or lower than those in the project scope considered in EIS Alternative B. The combination of identical or lower pumping rates for the HB AMAX Extension and the fact that the original modeling studies were steady state or equilibrium analyses allows the drawdowns estimated via the existing AECOM (2011) studies to serve as a conservative estimation of maximum drawdowns associated with the HB AMAX Extension.

Since the EIS was published, additional boring data, hydraulic conductivity estimates, and water level data have been collected at various Intrepid production and monitoring wells. As is typical for a groundwater model, the Rustler model was compiled using existing sub-surface data that reflected the best available information at that time, as required by NEPA. The question posed in this Technical Memorandum is "*Would updating the Rustler model with the additional data that was not available during the original formulation of the model change the predicted drawdowns and alter the BLM impact analysis completed to date?*" To answer this question it is necessary understand the original goal of creating this groundwater model; that goal was to assess the potential impacts to groundwater resources resulting from water extraction for the solution mining.

Given that the new data is mostly within the range of values used in the calibration process, the additional data points are localized, and that some variables (boundary conditions, including recharge) have no new data, the drawdown results are not expected to materially change. Updating the original model with the limited additional data, including the transient water levels, may improve the model calibration on a local basis and result in drawdown predictions slightly different than those obtained from the original model. The original model was run to provide a conservative, worse-case estimate of drawdowns. Given the drawdowns observed to date, it is obvious that the actual drawdowns are significantly less severe than the original model predicted (Figure TM-EA-002-19). This discrepancy in actual versus modeled drawdown is expected; the model was designed to be conservative. Under the original EIS, the modeled drawdown was considered an acceptable impact. An improved model may yield more accurate estimates of project drawdowns but these changes would likely reduce the drawdown extent. Such improvements would not alter the conclusions obtained from the original modeling effort; namely that the impact to the groundwater system arising from the operation of the production wells was acceptable. Therefore, there does not appear to be substantive added value for updating the model. The new results would show less impact than that predicted by the existing model. Accordingly, a reasonable path forward is the continued implementation of the current adaptive management approach including continued monitoring of actual drawdowns relative to the predicted scenario.

4 References

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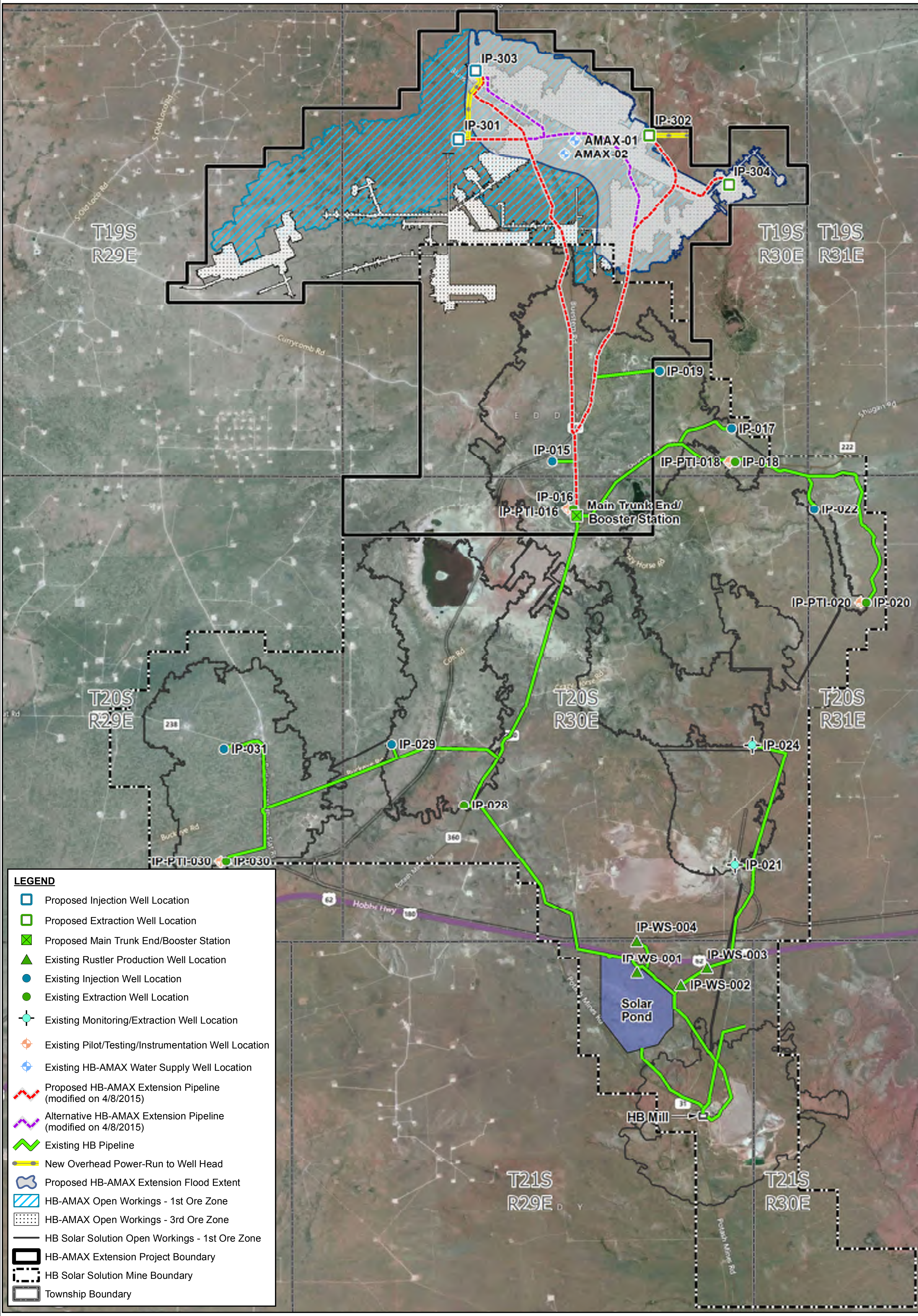
Attachments

Figure TM-EA-002-1	*General Infrastructure*
Figure TM-EA-002-2	*Location of the North Rustler Well Field*
Figure TM-EA-002-3	*Location of the Caprock Well Field Relative to Project Area*
Figure TM-EA-002-4	*Rustler Groundwater Model Domain*
Figure TM-EA-002-5	*Distribution of Calibration Targets*
Figure TM-EA-002-6	*Distribution of Hydraulic Conductivity in the Dewey Lake Red Beds*
Figure TM-EA-002-7	*Distribution of Hydraulic Conductivity in the Magenta Dolomite Aquifer*
Figure TM-EA-002-8	*Distribution of Hydraulic Conductivity in the Culebra Dolomite Aquifer*
Figure TM-EA-002-9	*Distribution of Hydraulic Conductivity in the Magenta Dolomite Aquifer – Enhanced Model*
Figure TM-EA-002-10	*Model Domain for the Caprock Analytical Model*
Figure TM-EA-002-11	*Current HB Solar Solution Mine Monitoring Well Network*
Figure TM-EA-002-12	*Current HB Solar Solution Mine Operational Components*
Figure TM-EA-002-13	*Rustler Preferred Model Predicted Drawdown, Alternative B*
Figure TM-EA-002-14	C*aprock Model Predicted Drawdown Alternative B, Pumping Rate = 2,090 gpm*
Figure TM-EA-002-15	*Caprock Model Predicted Drawdown Alternative B, Pumping Rate = 1,117 gpm*
Figure TM-EA-002-16	*Rustler Enhanced Model Predicted Drawdown, Alternative B*
Figure TM-EA-002-17	*Caprock Model Predicted Drawdown Alternative B, Pumping Rate = 1,597 gpm*
Figure TM-EA-002-18	*Caprock Model Predicted Drawdown Alternative B, Pumping Rate = 747 gpm*
Figure TM-EA-002-19	*Predicted and Observed Drawdown, March 2014*



LEGEND

- Proposed Injection Well Location
- Proposed Extraction Well Location
- Proposed Main Trunk End/Booster Station
- Existing Rustler Production Well Location
- Existing Injection Well Location
- Existing Extraction Well Location
- Existing Monitoring/Extraction Well Location
- Existing Pilot/Testing/Instrumentation Well Location
- Existing HB-AMAX Water Supply Well Location
- Proposed HB-AMAX Extension Pipeline (modified on 4/8/2015)
- Alternative HB-AMAX Extension Pipeline (modified on 4/8/2015)
- Existing HB Pipeline
- New Overhead Power-Run to Well Head
- Proposed HB-AMAX Extension Flood Extent
- HB-AMAX Open Workings - 1st Ore Zone
- HB-AMAX Open Workings - 3rd Ore Zone
- HB Solar Solution Open Workings - 1st Ore Zone
- HB-AMAX Extension Project Boundary
- HB Solar Solution Mine Boundary
- Township Boundary

NOTES:

1. Aerial imagery from esri.
2. Locations of existing pipelines, existing wells, proposed HB-AMAX pipelines, and proposed HB-AMAX wells provided by Intrepid Potash, LLC and further defined through field surveys.
3. Final pipeline route to be surveyed upon regulatory approval.
4. Horizontal coordinate system is NAD 1983 New Mexico State Plane East, units in feet.

INTREPID POTASH

Foth

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	MJH5	DATE:	MAY '15
REVIEWED BY:	JMH6	DATE:	MAY '15
APPROVED BY:		DATE:	

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FIGURE TM-EA-002-1

GENERAL INFRASTRUCTURE

Technical Memorandum TM-002, Groundwater Modeling Applicability
HB Solar Solution Mine - AMAX Extension

Scale: 0 3,000 6,000 Feet	Date: MAY 4, 2015
Drafted by: BJW1	Project No: 0014I016

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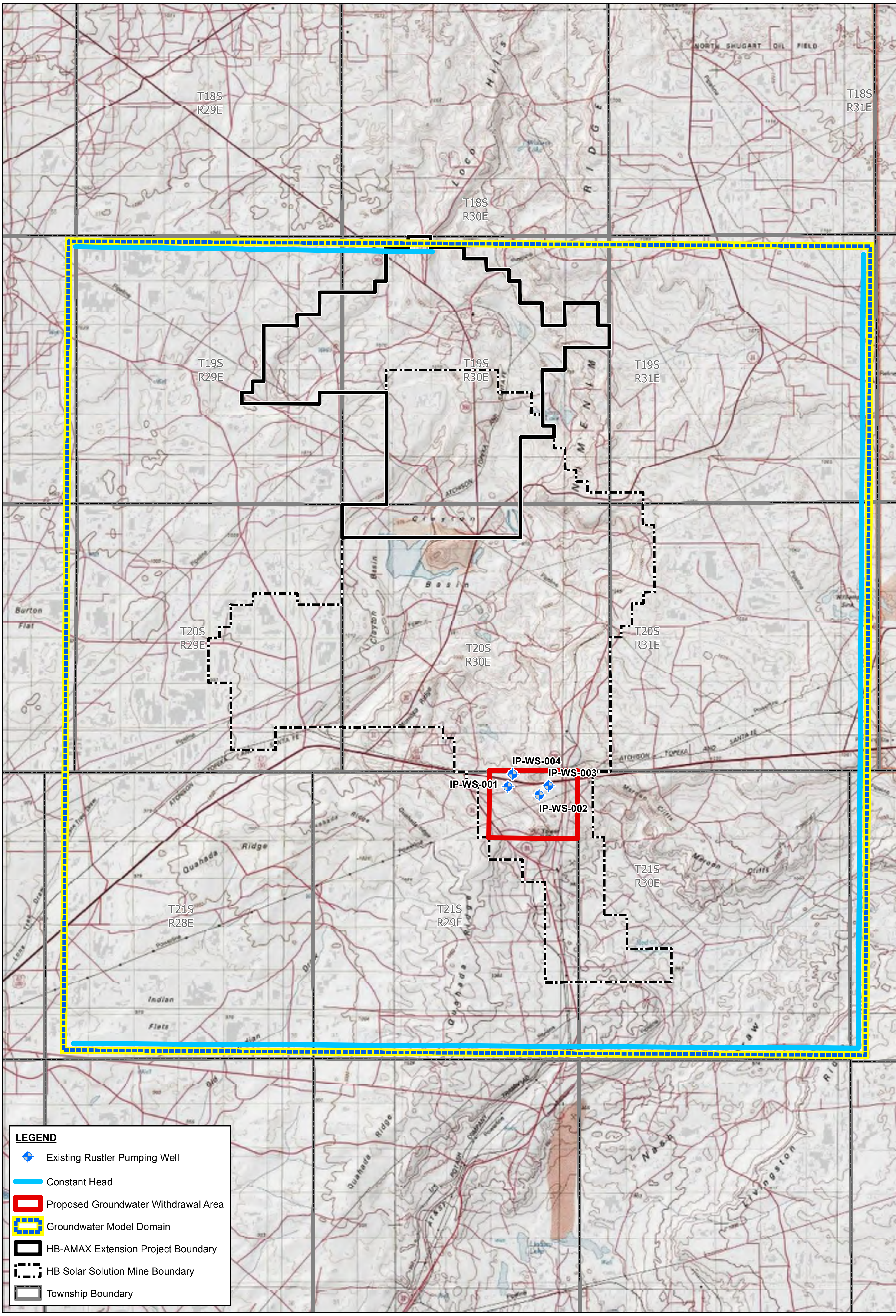

NOTES:

1. Basemap from esri.
2. Red box in center denotes the location of the "Section 2" area in which surface evaporation ponds and Rustler Formation production wells are located.
3. Figure orginally from AECOM, February 2011.
4. Horizontal coordinate system is NAD 1983 New Mexico State Plane East, units in feet.

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REVIEWED BY:	JMH6	DATE:	MAY '15
APPROVED BY:		DATE:	

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FIGURE TM-EA-002-2
LOCATION OF THE NORTH RUSTLER WELL FIELD
Technical Memorandum TM-002, Groundwater Modeling Applicability
HB Solar Solution Mine - AMAX Extension

Scale: 0 1 2 Miles	Date: MAY 4, 2015
Drafted by: BJW1	Project No: 0014I016

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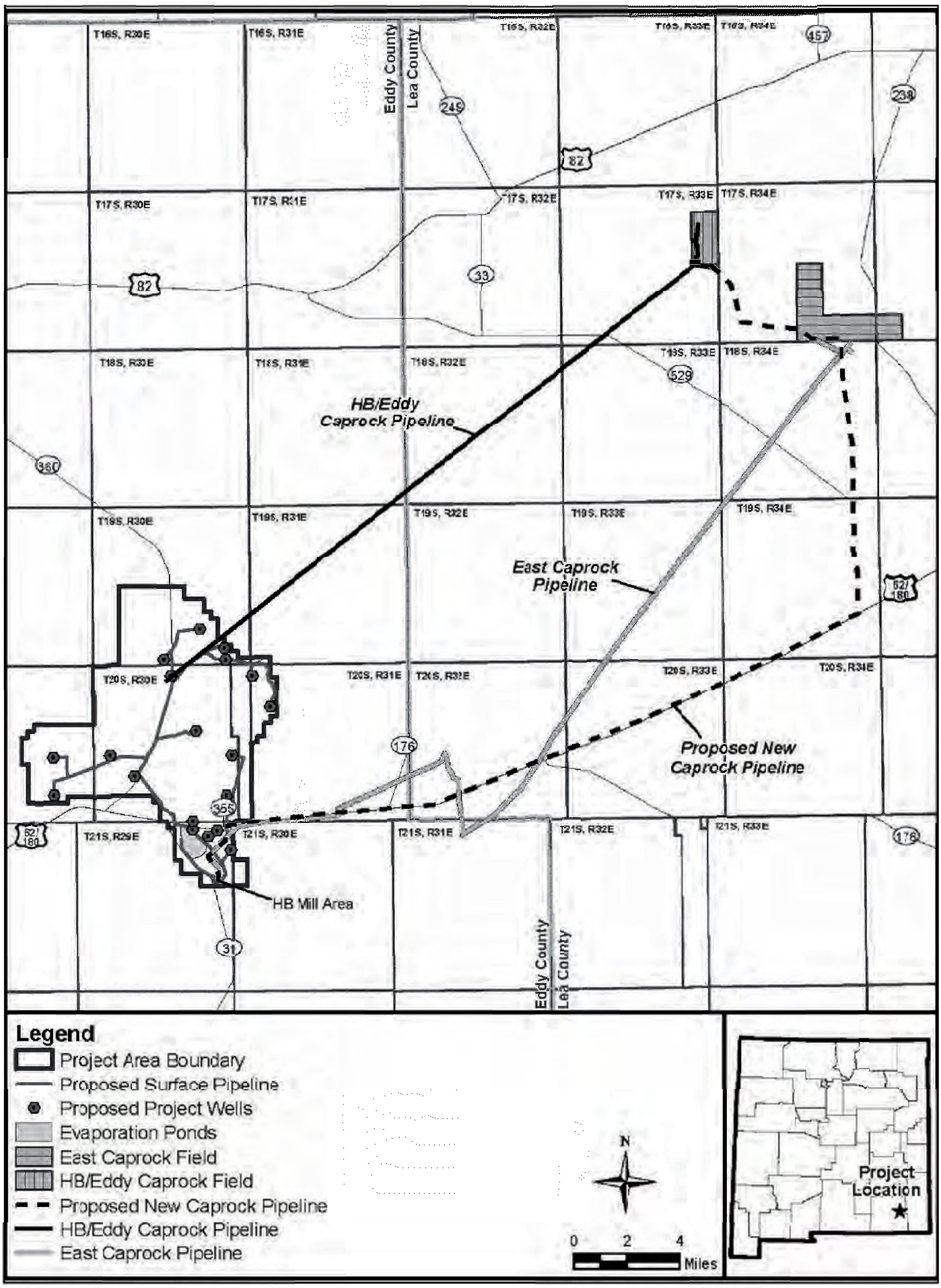

NOTES:
1. Figure from BLM, 2012.

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PREPARED BY:	MJH5		DATE:	MAY '15
REVIEWED BY:	JMH6		DATE:	MAY '15
APPROVED BY:			DATE:	

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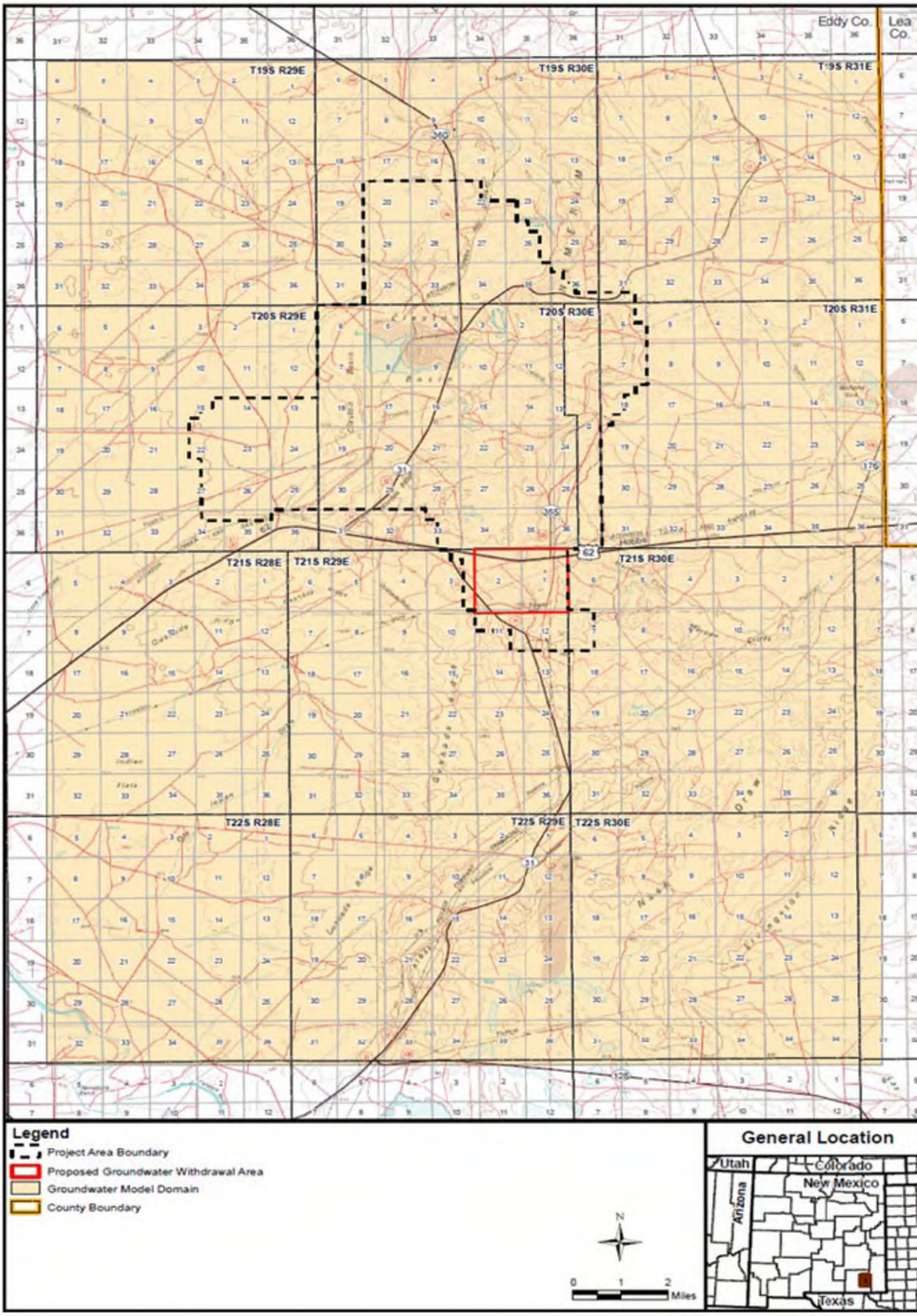
FIGURE TM-EA-002-3
LOCATION OF THE CAPROCK WELL FIELD RELATIVE TO PROJECT AREA
Technical Memorandum TM-002, Groundwater Modeling Applicability
HB Solar Solution Mine - AMAX Extension

Scale:	AS SHOWN	Date:	MAY 4, 2015
Drafted by:	BJW1	Project No:	0014I016

Path: X:\GB\IE\2014\14I016-00\GIS\mxd\Technical_Memorandum_TM-EA-002\Intrepid_HB_Amax_Caprock_Well_Field_Location_Map_11x17.mxd Date: 5/4/2015



NOTES:

1. Figure from Hydrological Assessment and Groundwater Modeling Report for the HB In-Situ Solution Mine Project EIS. AECOM, February 2011, Figure 7-1.

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REVISED	DATE	BY	DESCRIPTION	**FIGURE TM-EA-002-4** RUSTLER GROUNDWATER MODEL DOMAIN Technical Memorandum TM-002, Groundwater Modeling Applicability HB Solar Solution Mine - AMAX Extension
PREPARED BY:	MJH5		DATE: MAY '15	
REVIEWED BY:	JMH6		DATE: MAY '15	Scale: AS SHOWN / Date: MAY 4, 2015
APPROVED BY:			DATE:	Drafted by: BJW1 / Project No: 0014I016

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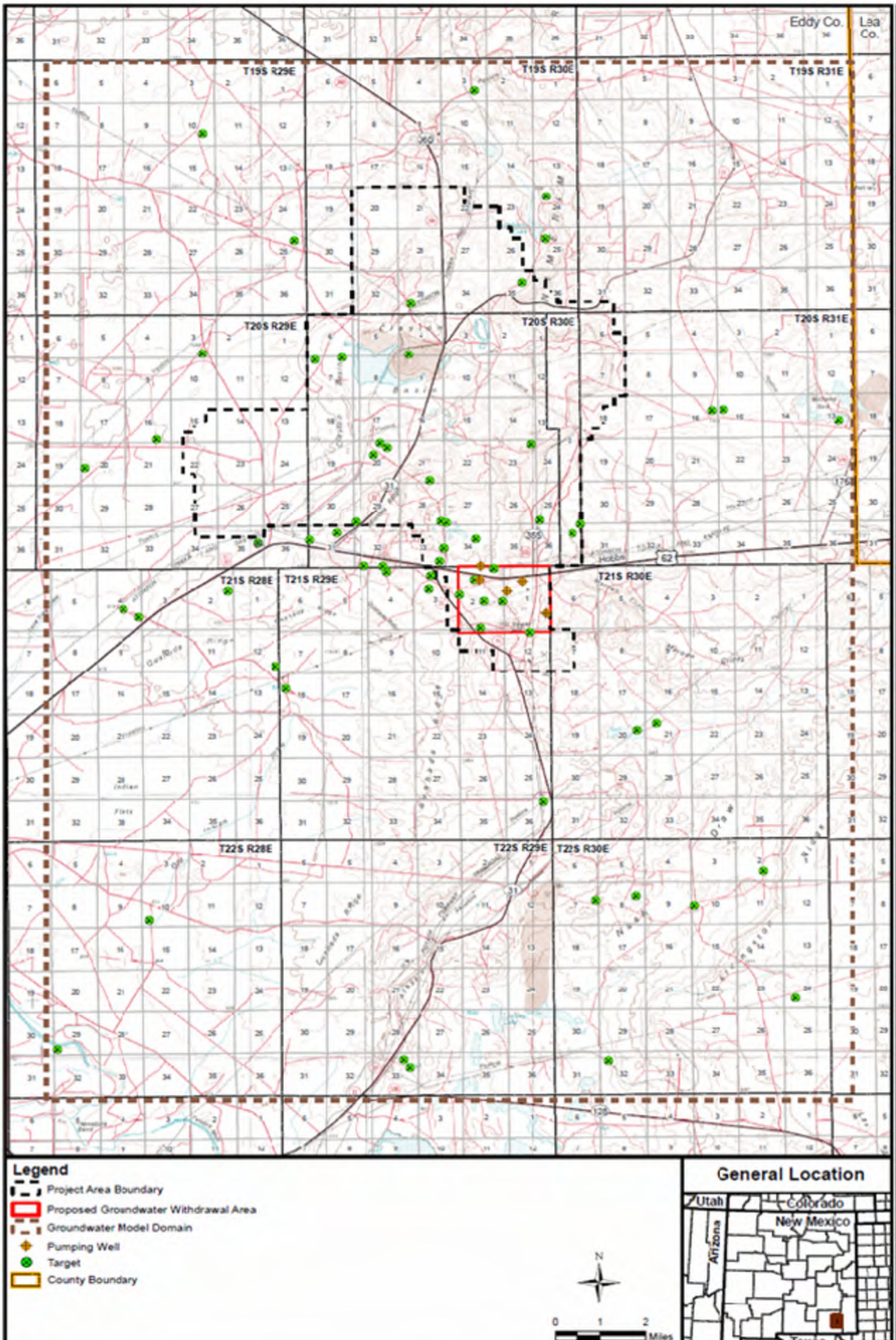

NOTES:
1. Figure from Hydrological Assessment and Groundwater Modeling Report for the HB In-Situ Solution Mine Project EIS. AECOM, February 2011, Figure 7-5.

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FIGURE TM-EA-002-5

DISTRIBUTION OF CALIBRATION TARGETS

Technical Memorandum TM-002, Groundwater Modeling Applicability
HB Solar Solution Mine - AMAX Extension

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Drafted by:	BJW1	Project No:	0014I016

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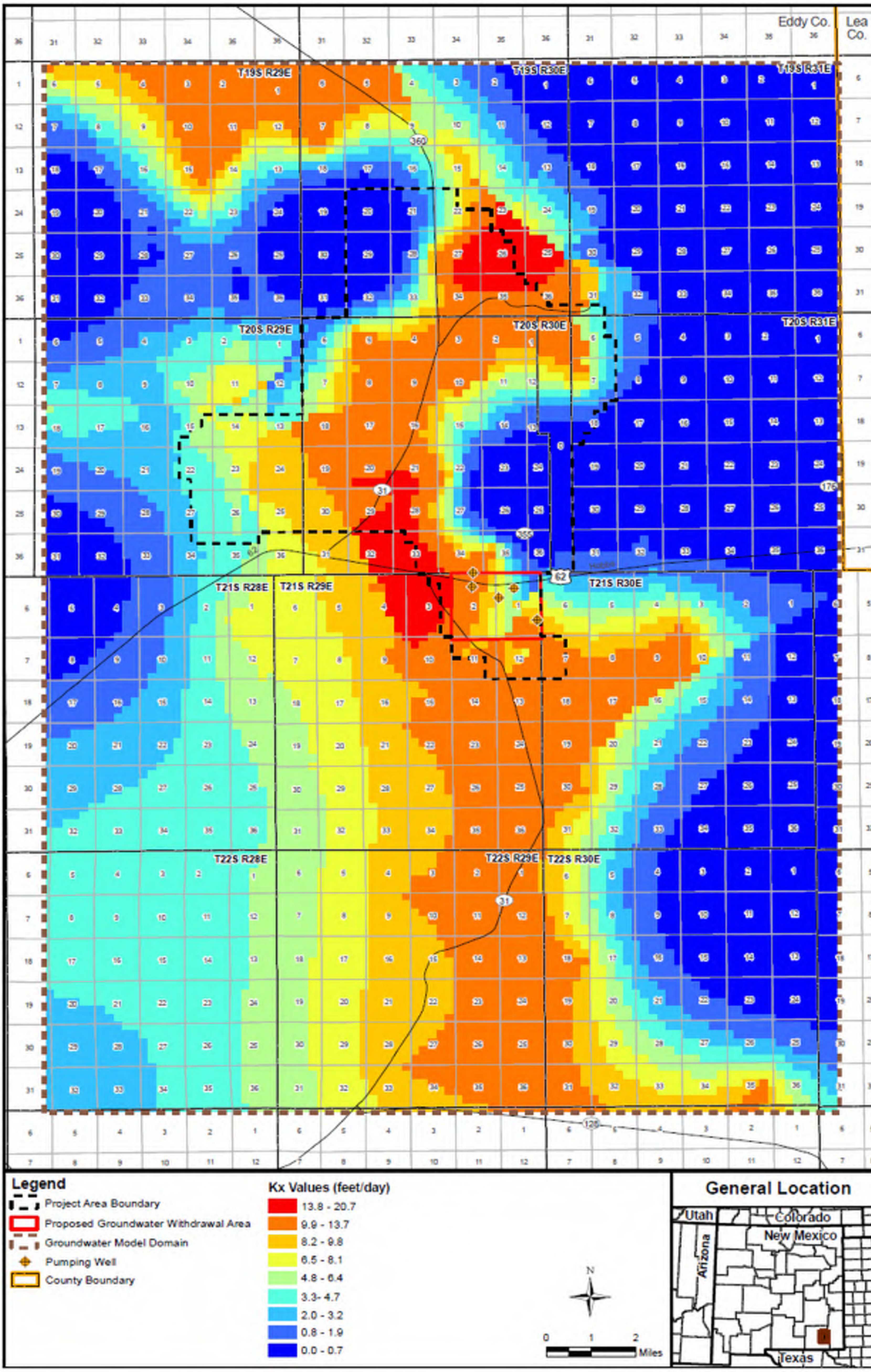

NOTES:

1. Figure from Hydrological Assessment and Groundwater Modeling Report for the HB In-Situ Solution Mine Project EIS. AECOM, February 2011, Figure 8-5.

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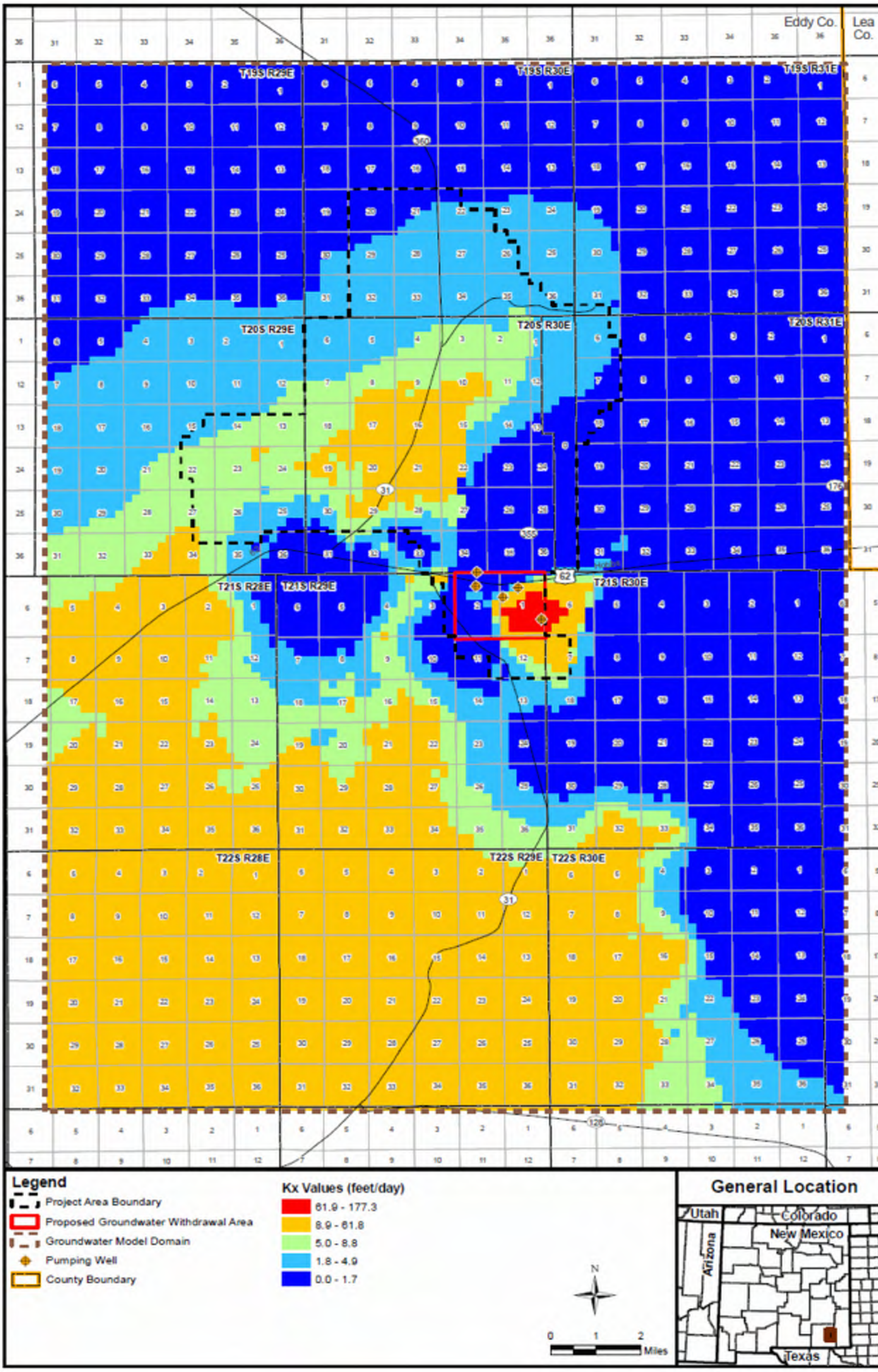
FIGURE TM-EA-002-6

DISTRIBUTION OF HYDRAULIC CONDUCTIVITY IN THE DEWEY LAKE RED BEDS

Technical Memorandum TM-002, Groundwater Modeling Applicability
HB Solar Solution Mine - AMAX Extension

Scale: AS SHOWN	Date: MAY 4, 2015
Drafted by: BJW1	Project No: 0014I016

Path: X:\GB\IE\2014\14I016-00\GIS\mxd\Technical_Memorandum_TM-EA-002\Intrepid_HB_Amax_HydroCond_DeweyLakeRedBeds_11x17.mxd Date: 5/4/2015



NOTES:

1. Figure from Hydrological Assessment and Groundwater Modeling Report for the HB In-Situ Solution Mine Project EIS. AECOM, February 2011, Figure 8-6.

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PREPARED BY: MJH5			DATE: MAY '15
REVIEWED BY: JMH6			DATE: MAY '15
APPROVED BY:			DATE:

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FIGURE TM-EA-002-7

DISTRIBUTION OF HYDRAULIC CONDUCTIVITY IN THE MAGENTA DOLOMITE AQUIFER

Technical Memorandum TM-002, Groundwater Modeling Applicability HB Solar Solution Mine - AMAX Extension

Scale:	AS SHOWN	Date:	MAY 4, 2015
Drafted by:	BJW1	Project No:	0014I016

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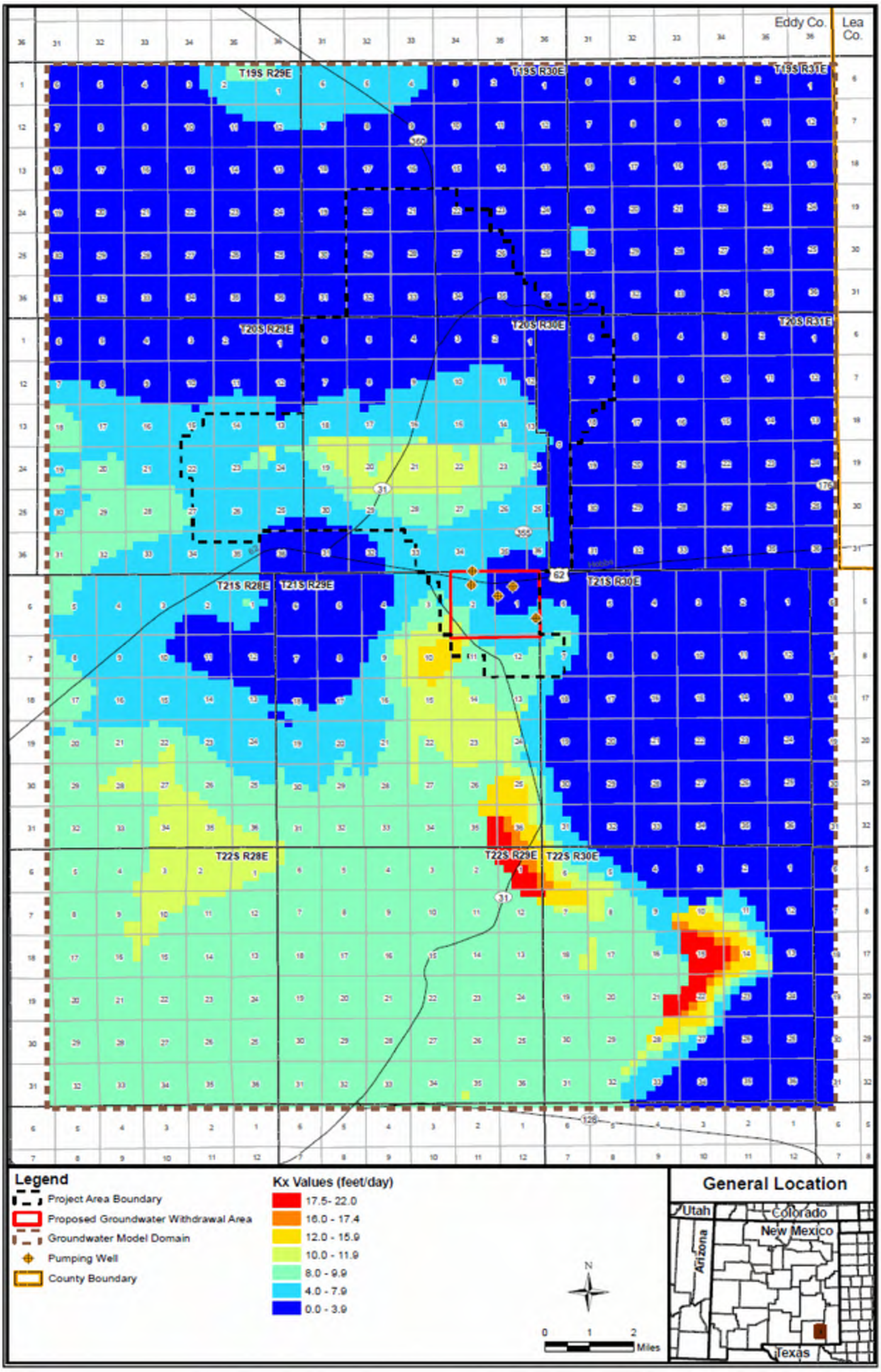

NOTES:
1. Figure from Hydrological Assessment and Groundwater Modeling Report for the HB In-Situ Solution Mine Project EIS. AECOM, February 2011, Figure 8-7.

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FIGURE TM-EA-002-8
DISTRIBUTION OF HYDRAULIC CONDUCTIVITY IN THE CULEBRA DOLOMITE AQUIFER
Technical Memorandum TM-002, Groundwater Modeling Applicability
HB Solar Solution Mine - AMAX Extension

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Drafted by:	BJW1	Project No:	0014I016

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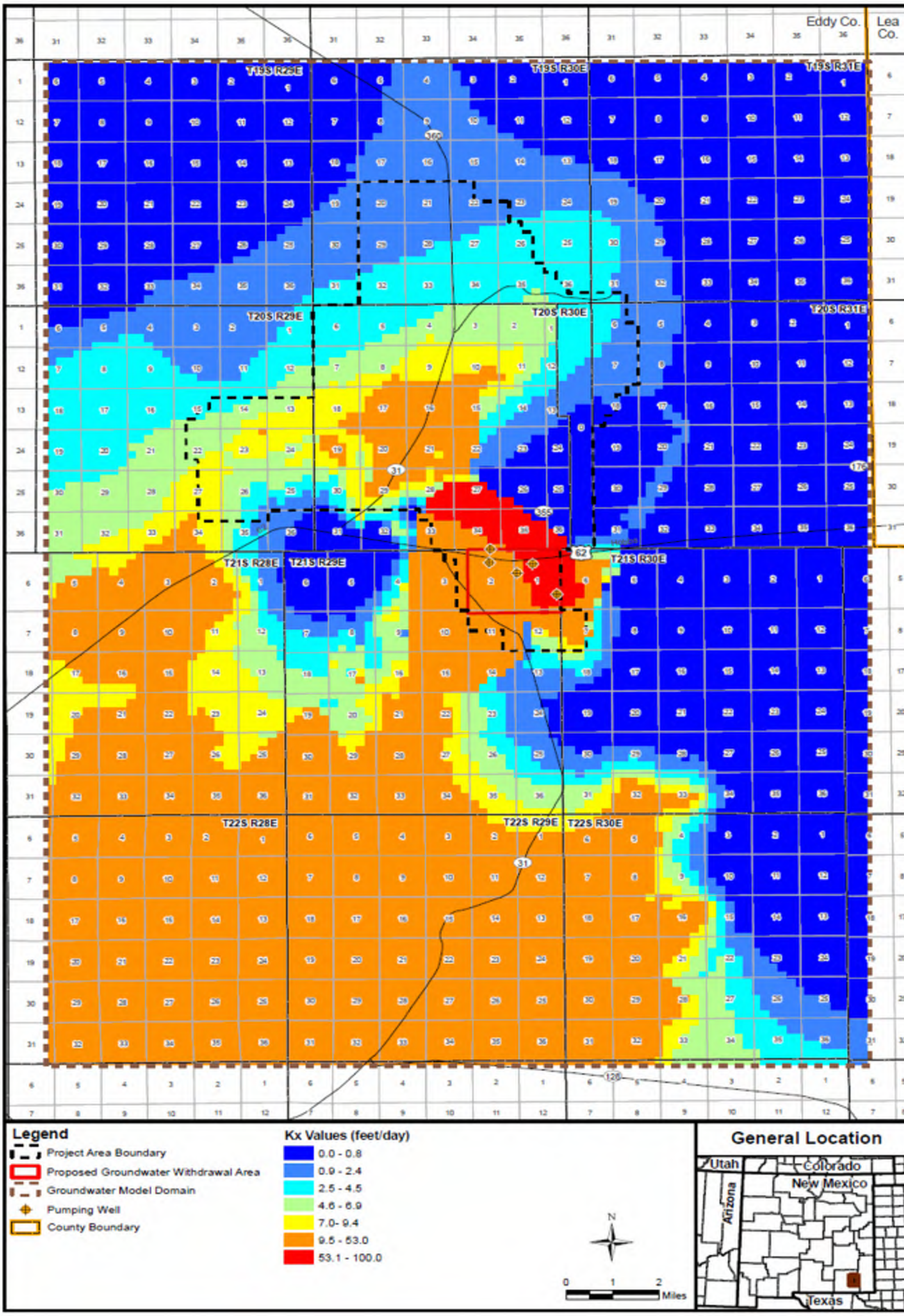

NOTES:

1. Figure from Hydrological Assessment and Groundwater Modeling Report for the HB In-Situ Solution Mine Project EIS. AECOM, February 2011, Figure 9-2.

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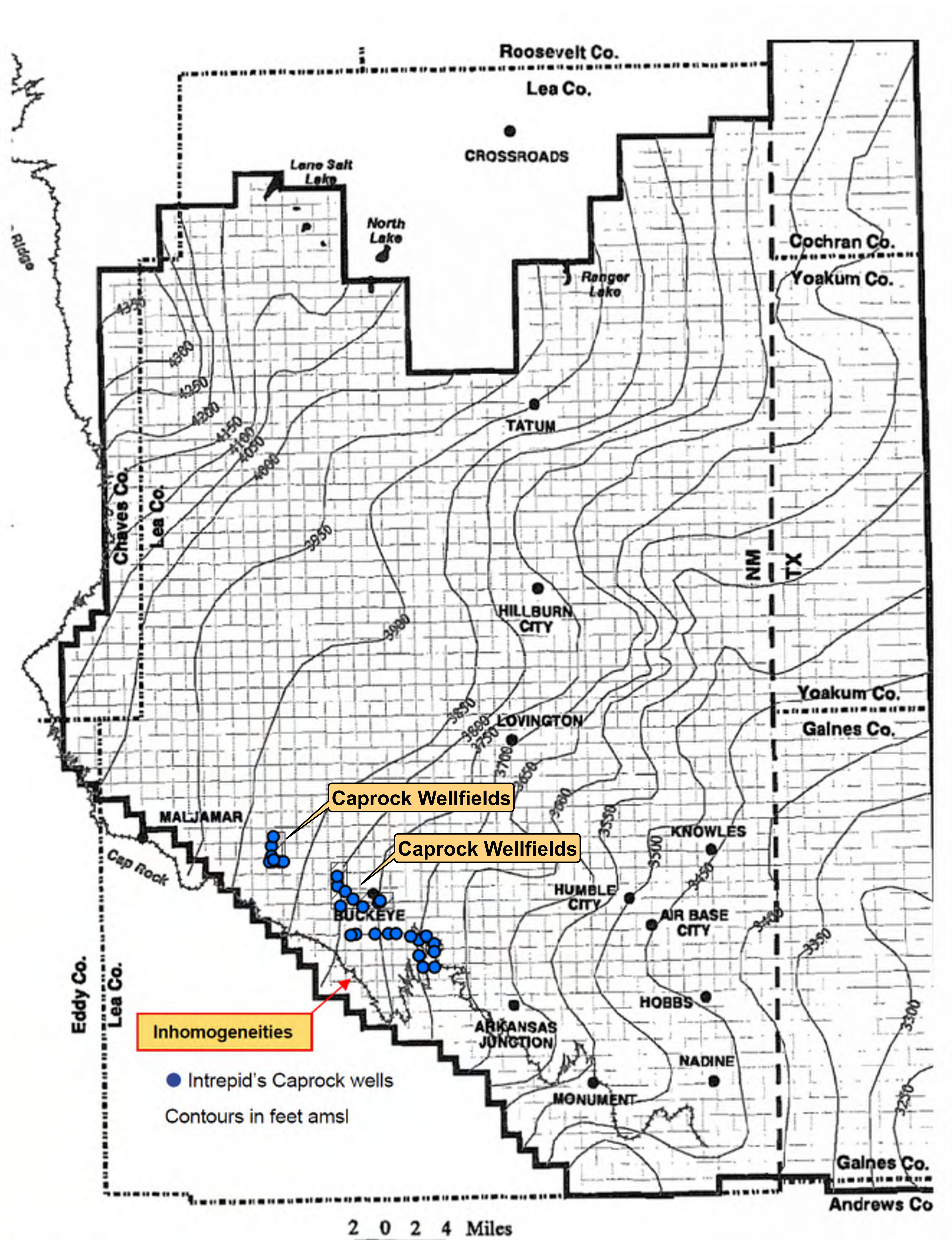
FIGURE TM-EA-002-9

DISTRIBUTION OF HYDRAULIC CONDUCTIVITY IN THE MAGENTA DOLOMITE AQUIFER - ENHANCED MODEL

Technical Memorandum TM-002, Groundwater Modeling Applicability HB Solar Solution Mine - AMAX Extension

Scale: AS SHOWN	Date: MAY 4, 2015
Drafted by: BJW1	Project No: 0014I016

Path: X:\GB\IE\2014\14I016-00\GIS\mxd\Technical_Memorandum_TM-EA-002\Intrepid_HB_Amax_HydroCond_MagentaDolomite_EM_11x17.mxd Date: 5/4/2015



Source: Musharrafieh and Chudnoff 1999

NOTES:

1. Figure from Hydrological Assessment and Groundwater Modeling Report for the HB In-Situ Solution Mine Project EIS. AECOM, February 2011, Figure 10-2.

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FIGURE TM-EA-002-10

MODEL DOMAIN FOR THE CAPROCK ANALYTICAL MODEL

Technical Memorandum TM-002, Groundwater Modeling Applicability HB Solar Solution Mine - AMAX Extension

Scale: AS SHOWN	Date: MAY 4, 2015
Drafted by: BJW1	Project No: 0014I016

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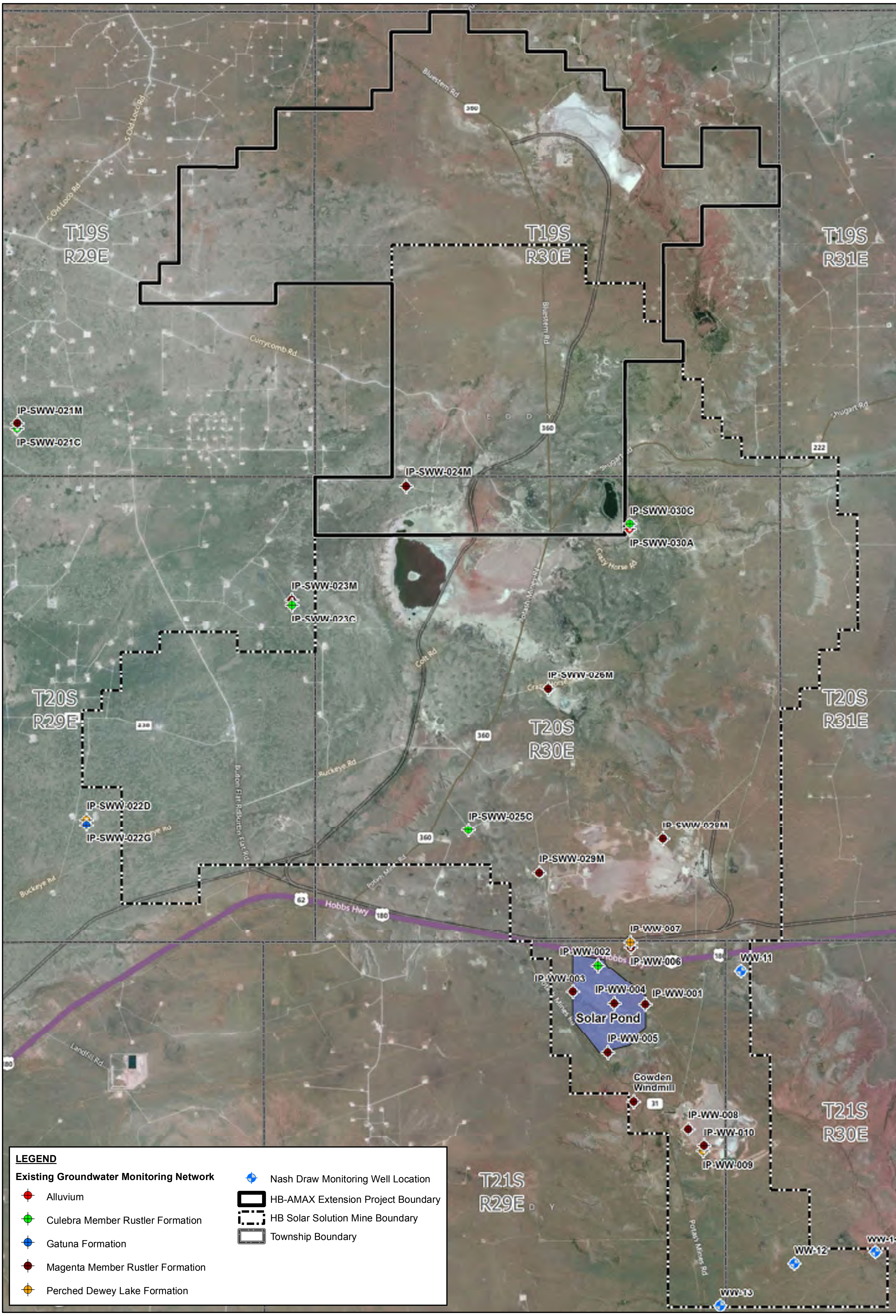

NOTES:

1. Aerial imagery from esri.
2. Location of monitoring wells based on site survey coordinates.
3. Horizontal coordinate system is NAD 1983 New Mexico State Plane East, units in feet.

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REVIEWED BY:	JMH6	DATE:	MAY '15
APPROVED BY:		DATE:	

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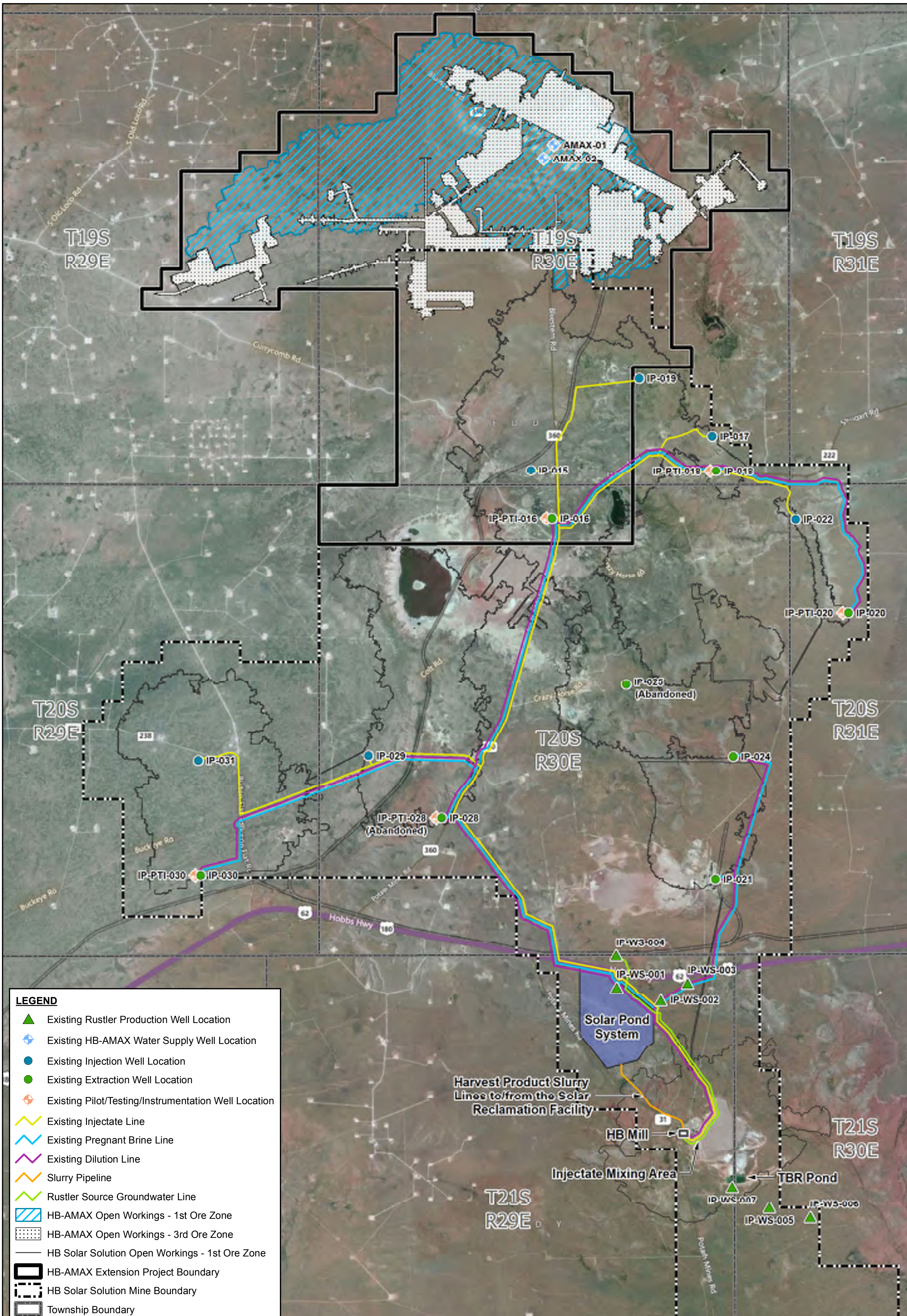
FIGURE TM-EA-002-11

CURRENT HB SOLAR SOLUTION MINE MONITORING WELL NETWORK

Technical Memorandum TM-002, Groundwater Modeling Applicability
HB Solar Solution Mine - AMAX Extension

Scale: 0 3,000 6,000 Feet	Date: MAY 4, 2015
Drafted by: BJW1	Project No: 0014I016

Path: X:\GB\IE\2014\14I016-00\GIS\mxd\Technical_Memorandum_TM-EA-002\Intrepid_HB_Amax_HB Solar Solution Mine Monitoring_Points_11x17.mxd Date: 5/5/2015



NOTES:

1. Aerial imagery from esri.
2. Locations of existing pipelines, existing wells, proposed HB-AMAX pipelines, and proposed HB-AMAX wells provided by Intrepid Potash, LLC.
3. Location of existing HB Solar Solution Mine Infrastructure from as-built survey information provided by Intrepid Potash, LLC.
4. Horizontal coordinate system is NAD 1983 New Mexico State Plane East, units in feet.

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PREPARED BY:	MJH5	DATE:	MAY '15
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APPROVED BY:		DATE:	

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FIGURE TM-EA-002-12

CURRENT HB SOLAR SOLUTION MINE OPERATIONAL COMPONENTS

Technical Memorandum TM-002, Groundwater Modeling Applicability

HB Solar Solution Mine - AMAX Extension

Scale: 0 3,000 6,000 Feet		Date:	MAY 4, 2015
Drafted by:	BJW1	Project No:	0014I016

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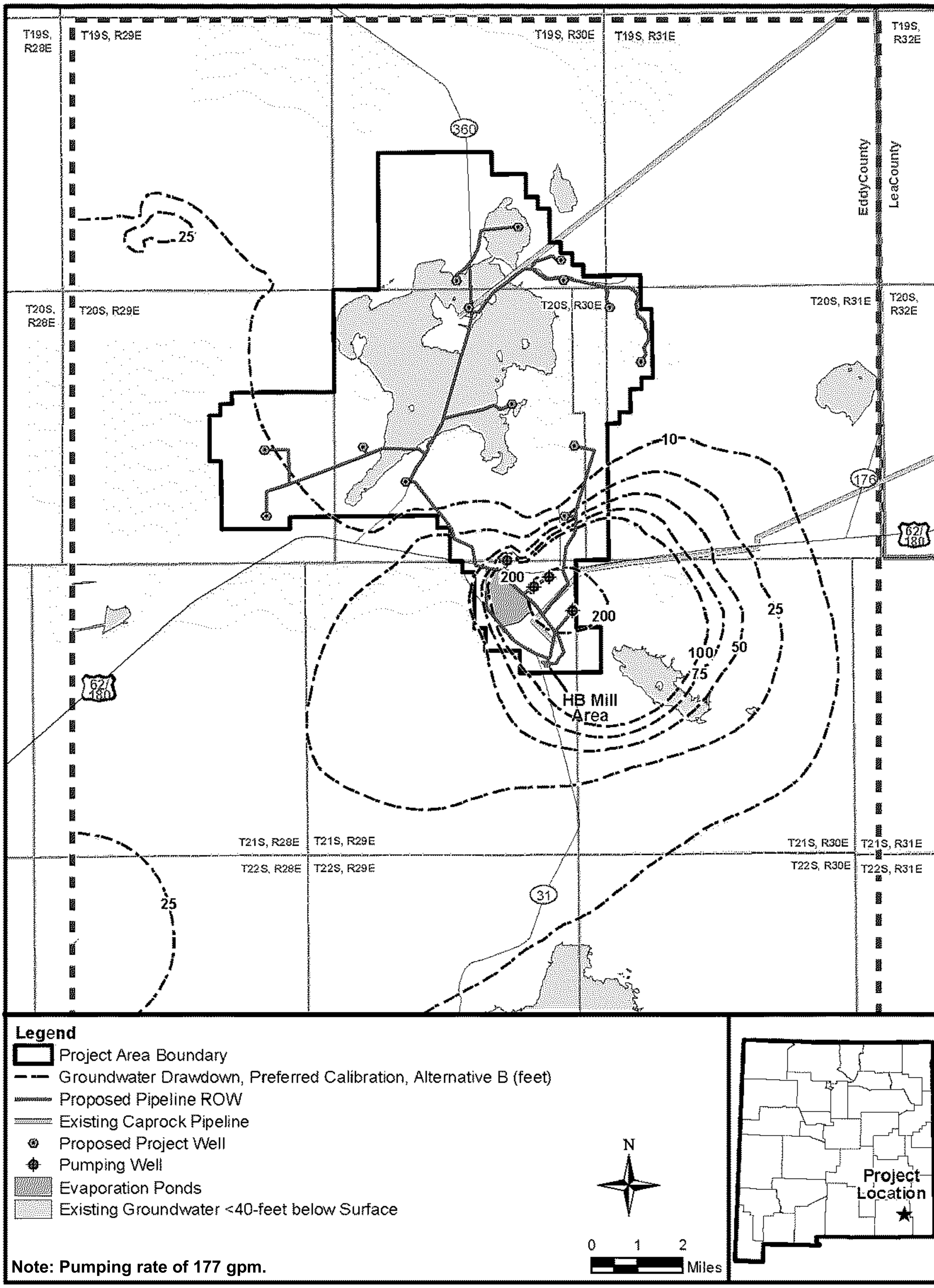

NOTES:
1. Figure from Hydrological Assessment and Groundwater Modeling Report for the HB In-Situ Solution Mine Project EIS. AECOM, February 2011, Figure 12-3.

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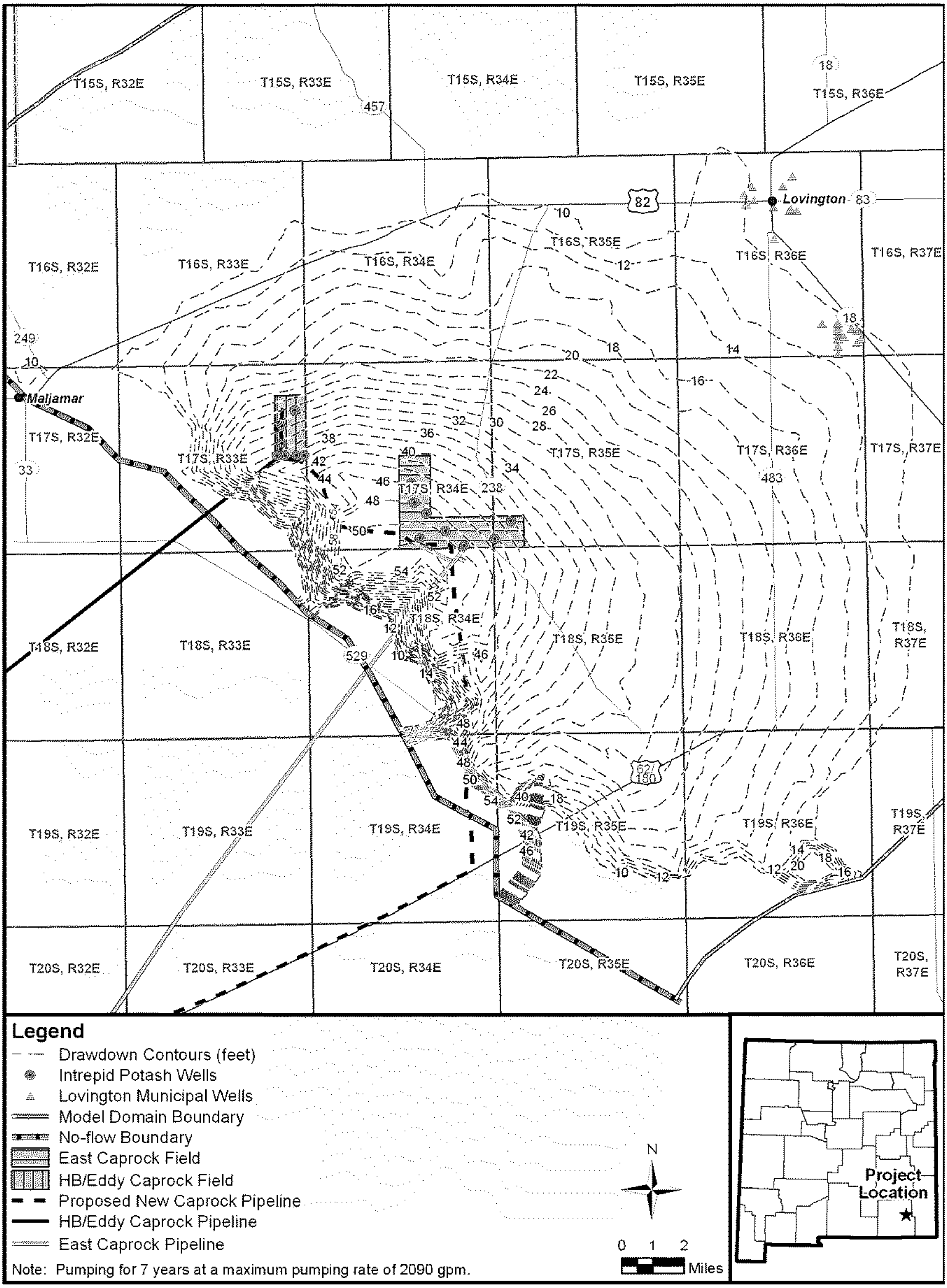
FIGURE TM-EA-002-13
RUSTLER PREFERRED MODEL PREDICTED DRAWDOWN, ALTERNATIVE B
Technical Memorandum TM-002, Groundwater Modeling Applicability HB Solar Solution Mine - AMAX Extension

Scale: AS SHOWN	Date: MAY 4, 2015
Drafted by: BJW1	Project No: 0014I016

Path: X:\GB\IE\2014\14I016-00\GIS\mxd\Technical_Memorandum_TM-EA-002\Intrepid_HB_Amax_RusterModelDrawdown_11x17.mxd Date: 5/4/2015



NOTES:

1. Figure from Hydrological Assessment and Groundwater Modeling Report for the HB In-Situ Solution Mine Project EIS. AECOM, February 2011, Figure 12-1.

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FIGURE TM-EA-002-14

CAPROCK MODEL PREDICTED DRAWDOWN
ALTERNATIVE B, PUMPING RATE = 2090 GPM

Technical Memorandum TM-002, Groundwater Modeling Applicability
HB Solar Solution Mine - AMAX Extension

Scale: AS SHOWN	Date: MAY 4, 2015
Drafted by: BJW1	Project No: 0014I016

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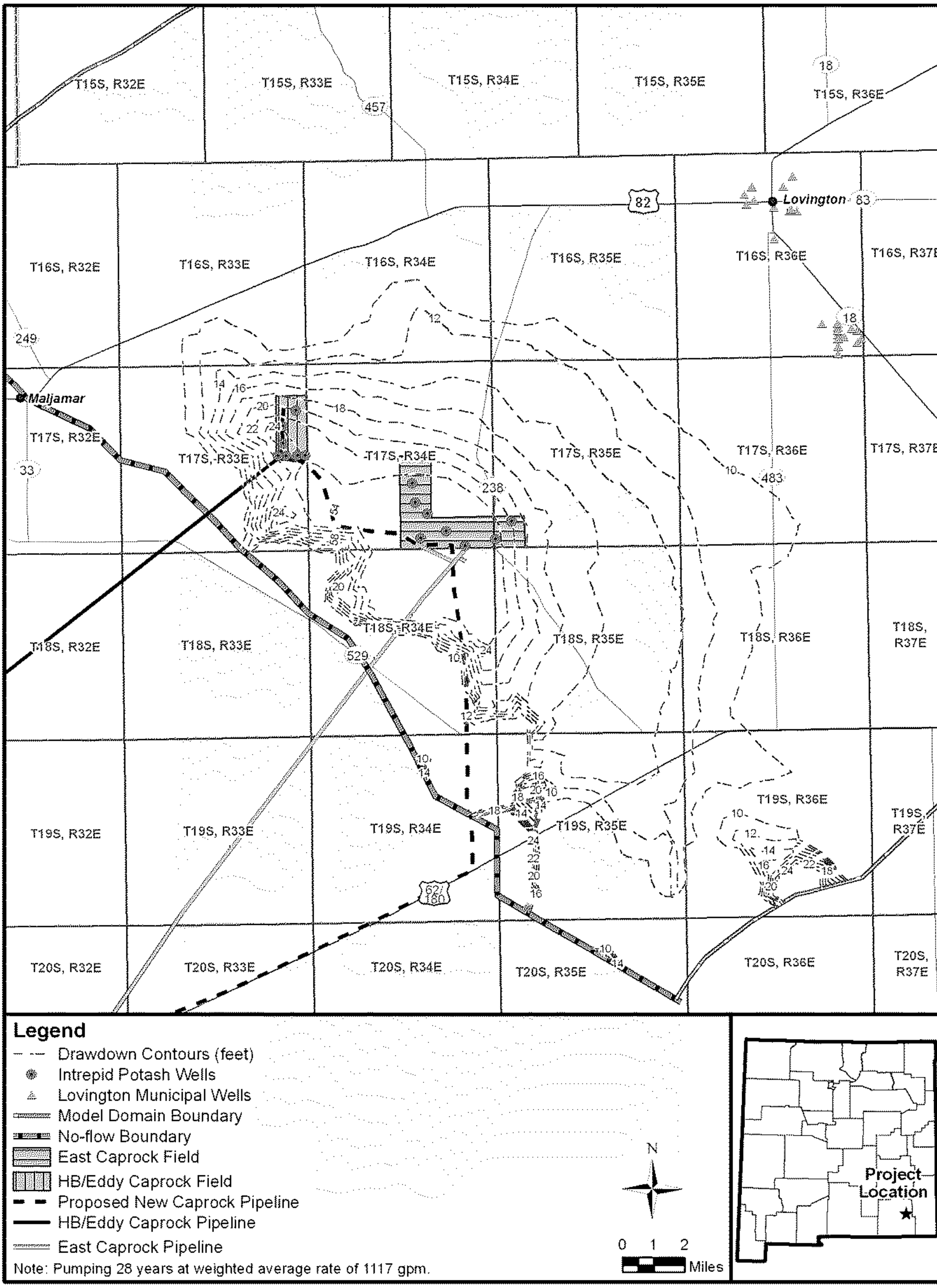

NOTES:

1. Figure from Hydrological Assessment and Groundwater Modeling Report for the HB In-Situ Solution Mine Project EIS. AECOM, February 2011, Figure 12-2.

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PREPARED BY: MJH5 DATE: MAY '15

REVIEWED BY: JMH6 DATE: MAY '15

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FIGURE TM-EA-002-15

CAPROCK MODEL PREDICTED DRAWDOWN
ALTERNATIVE B, PUMPING RATE = 1,117 GPM

Technical Memorandum TM-002, Groundwater Modeling Applicability
HB Solar Solution Mine - AMAX Extension

Scale: AS SHOWN Date: MAY 4, 2015

Drafted by: BJW1 Project No: 0014I016

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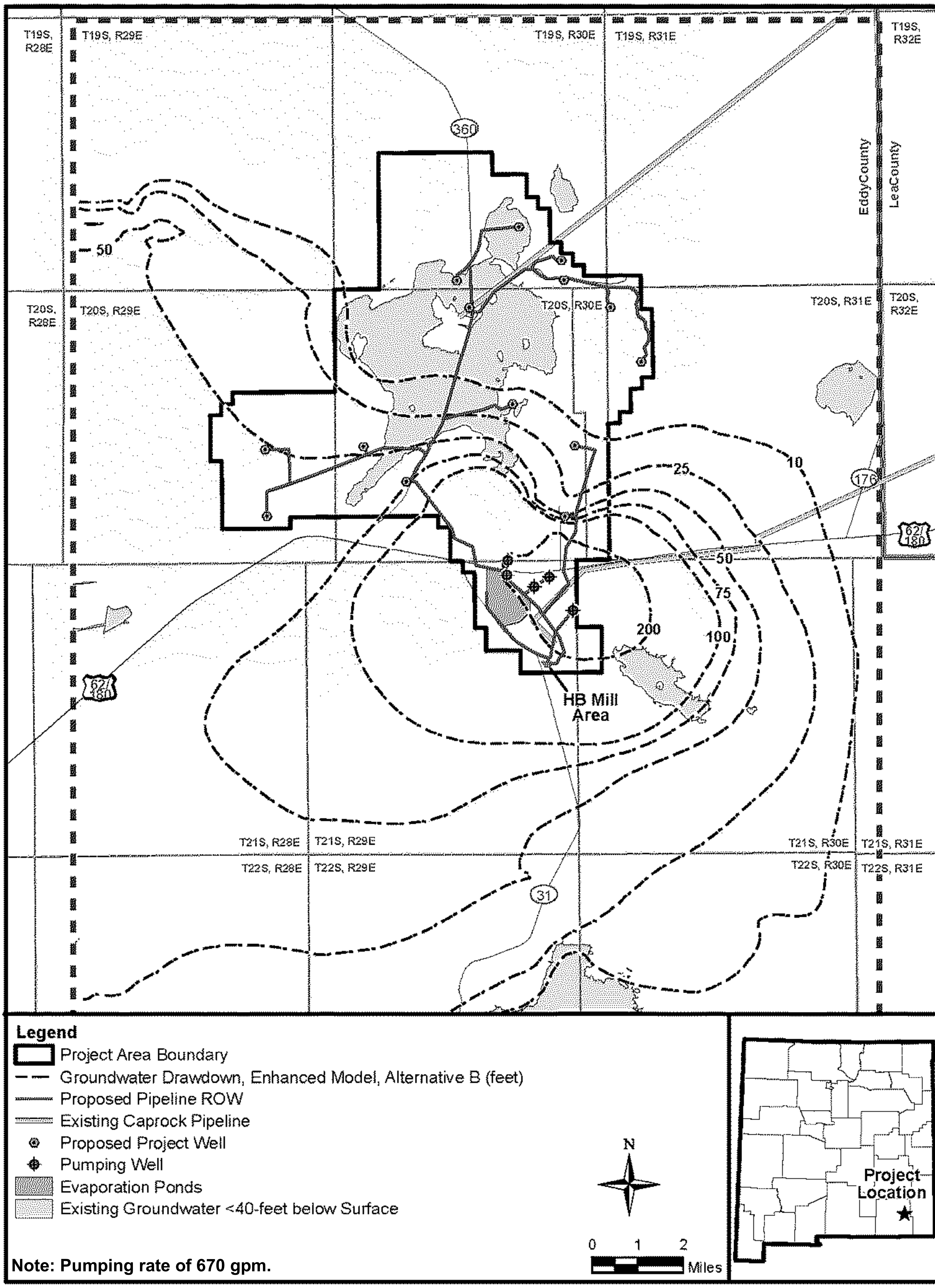

NOTES:

1. Figure from Hydrological Assessment and Groundwater Modeling Report for the HB In-Situ Solution Mine Project EIS. AECOM, February 2011, Figure 12-6.

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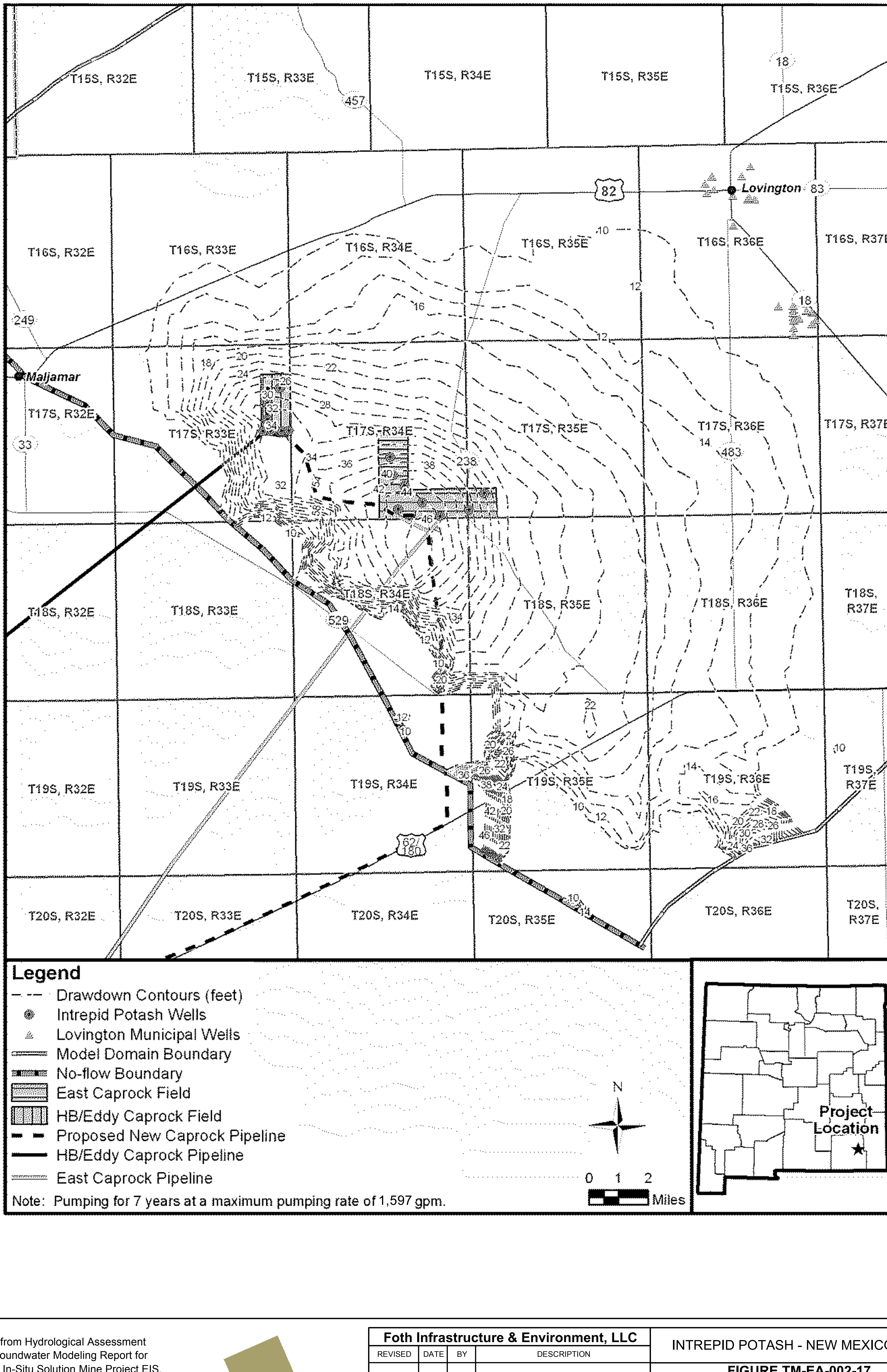
FIGURE TM-EA-002-16

RUSTLER ENHANCED MODEL PREDICTED DRAWDOWN, ALTERNATIVE B

Technical Memorandum TM-002, Groundwater Modeling Applicability HB Solar Solution Mine - AMAX Extension

Scale: AS SHOWN	Date: MAY 4, 2015
Drafted by: BJW1	Project No: 0014I016

Path: X:\GB\IE\2014\14I016-00\GIS\mxd\Technical_Memorandum_TM-EA-002\Intrepid_HB_Amax_RustlerEnhancedModel_AltB_11x17.mxd Date: 5/4/2015



NOTES:
1. Figure from Hydrological Assessment and Groundwater Modeling Report for the HB In-Situ Solution Mine Project EIS. AECOM, February 2011, Figure 12-4.

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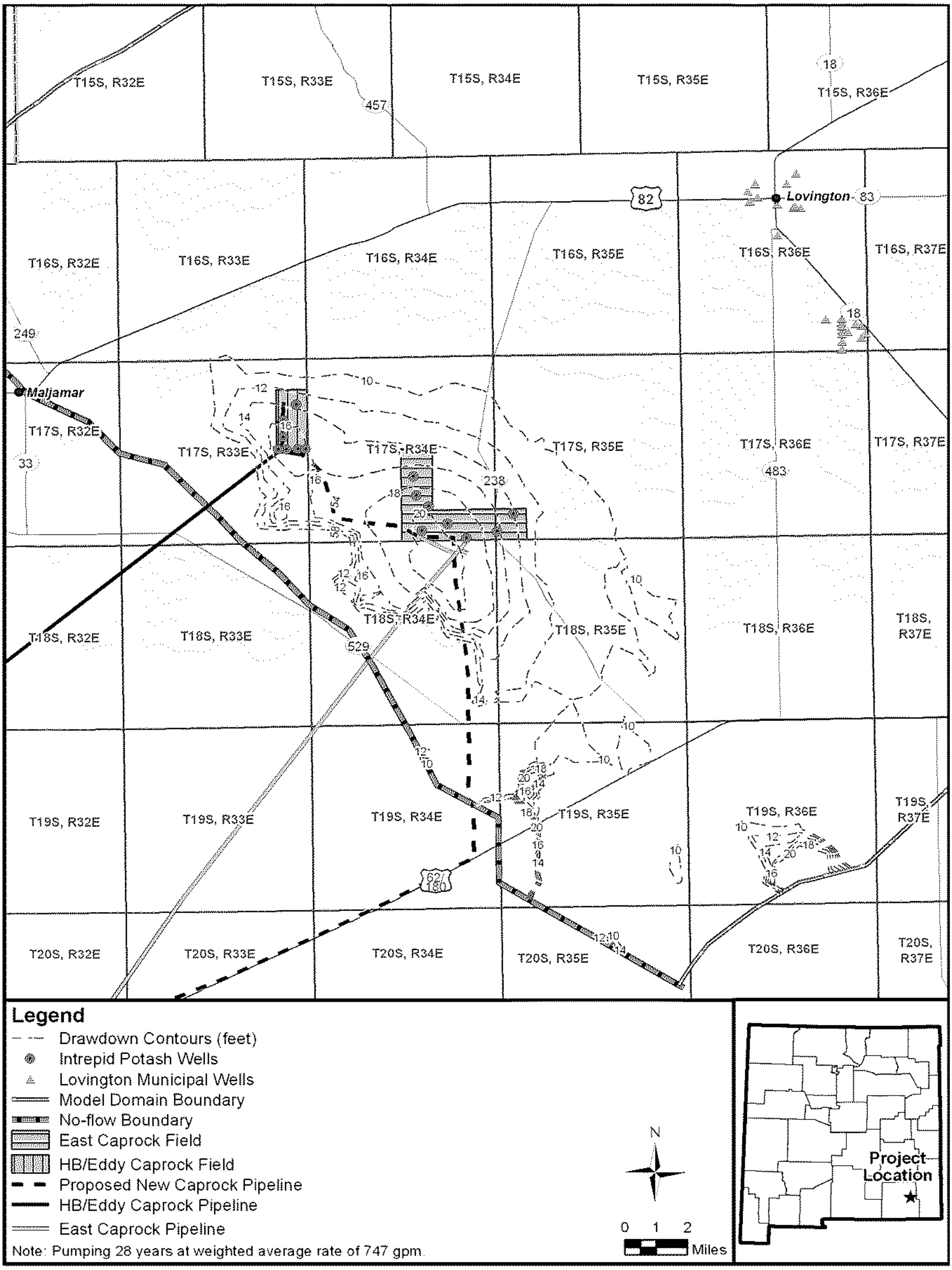
FIGURE TM-EA-002-17
CAPROCK MODEL PREDICTED DRAWDOWN
ALTERNATIVE B, PUMPING RATE = 1,597 GPM
Technical Memorandum TM-002, Groundwater Modeling Applicability
HB Solar Solution Mine - AMAX Extension

Scale: AS SHOWN	Date: MAY 4, 2015
Drafted by: BJW1	Project No: 0014I016

Path: X:\GB\IE\2014\14I016-00\GIS\mxd\Technical_Memorandum_TM-EA-002\Intrepid_HB_Amax_CaprockModel_PredictedDrawdown_AltB_1597gpm_11x17.mxd Date: 5/4/2015



NOTES:
1. Figure from Hydrological Assessment and Groundwater Modeling Report for the HB In-Situ Solution Mine Project EIS. AECOM, February 2011, Figure 12-5.

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REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	MJH5	DATE:	MAY '15
REVIEWED BY:	JMH6	DATE:	MAY '15
APPROVED BY:		DATE:	

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FIGURE TM-EA-002-18
CAPROCK MODEL PREDICTED DRAWDOWN
ALTERNATIVE B, PUMPING RATE = 747 GPM
Technical Memorandum TM-002, Groundwater Modeling Applicability
HB Solar Solution Mine - AMAX Extension

Scale:	AS SHOWN	Date:	MAY 4, 2015
Drafted by:	BJW1	Project No:	0014I016

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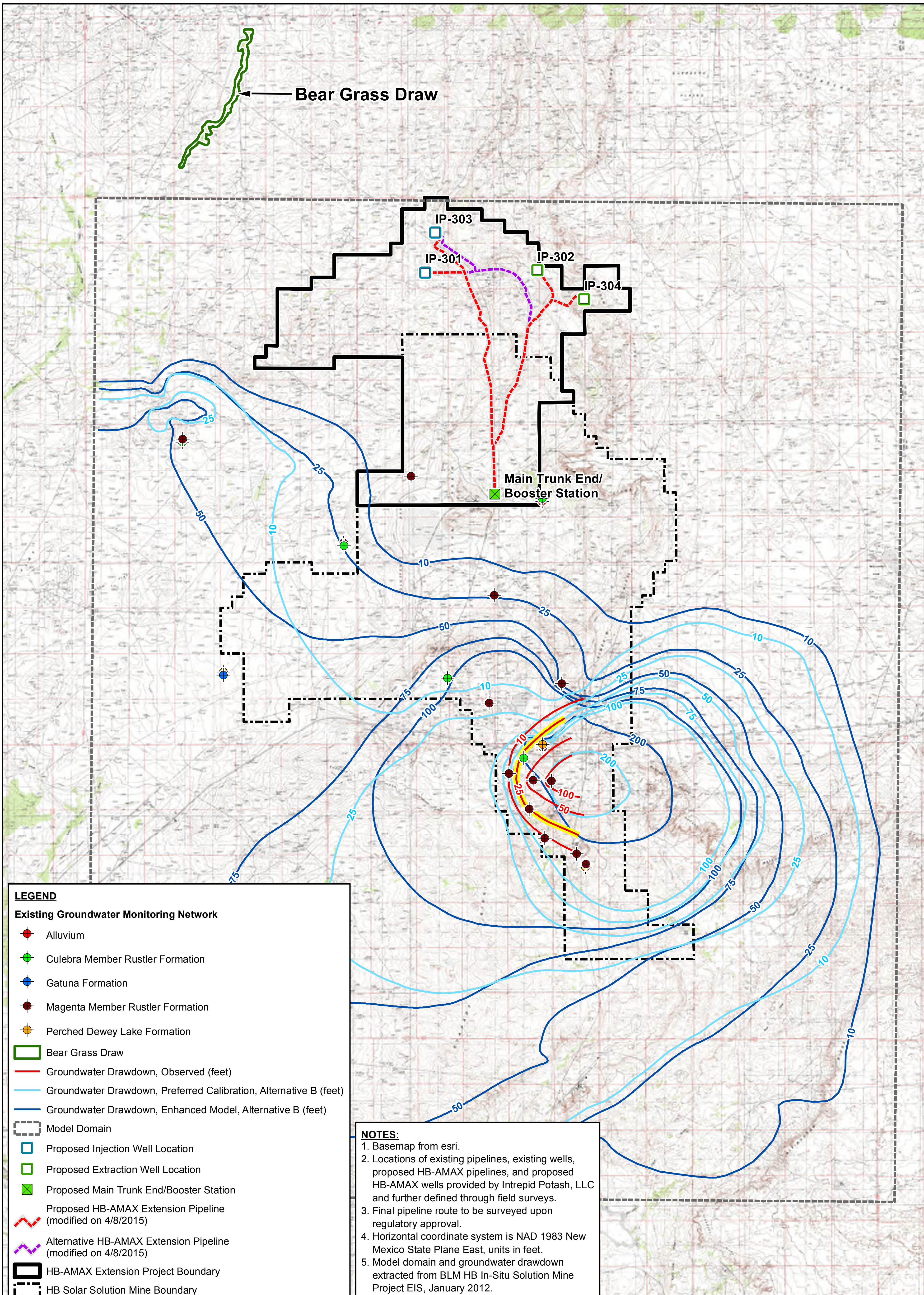

LEGEND

Existing Groundwater Monitoring Network

- Alluvium
- Culebra Member Rustler Formation
- Gatuna Formation
- Magenta Member Rustler Formation
- Perched Dewey Lake Formation
- Bear Grass Draw
- Groundwater Drawdown, Observed (feet)
- Groundwater Drawdown, Preferred Calibration, Alternative B (feet)
- Groundwater Drawdown, Enhanced Model, Alternative B (feet)
- Model Domain
- Proposed Injection Well Location
- Proposed Extraction Well Location
- Proposed Main Trunk End/Booster Station
- Proposed HB-AMAX Extension Pipeline (modified on 4/8/2015)
- Alternative HB-AMAX Extension Pipeline (modified on 4/8/2015)
- HB-AMAX Extension Project Boundary
- HB Solar Solution Mine Boundary

NOTES:

1. Basemap from esri.
2. Locations of existing pipelines, existing wells, proposed HB-AMAX pipelines, and proposed HB-AMAX wells provided by Intrepid Potash, LLC and further defined through field surveys.
3. Final pipeline route to be surveyed upon regulatory approval.
4. Horizontal coordinate system is NAD 1983 New Mexico State Plane East, units in feet.
5. Model domain and groundwater drawdown extracted from BLM HB In-Situ Solution Mine Project EIS, January 2012.

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PREPARED BY:	MJH5	DATE:	MAY '15
REVIEWED BY:	JMH6	DATE:	MAY '15
APPROVED BY:		DATE:	

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FIGURE TM-EA-002-19

PREDICTED AND OBSERVED
DRAWDOWN, MARCH 2014

Technical Memorandum TM-002, Groundwater Modeling Applicability
HB Solar Solution Mine - AMAX Extension

Scale: 0 1 2 Miles	Date: MAY 4, 2015
Drafted by: BJW1	Project No: 0014I016

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